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THE MILKY WAY.

J. L. ADAMS.

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A Memorandum to accompany the books "The Milky Way" and "The Infinity of the Starry Universe," and the Supplement thereto.

My explanation of the Milky Way has received but little attention in astronomical circles, so far as I am aware, because possibly at the first glance it appears wholly incredible, and doubtless there is also the thought present that there can be nothing in the simple explanation I offer or it would surely have been discovered long since by some of the many men of high intelligence who have given their attention to the study of the heavens. The apparent difficulties, however, in the way of reconciling the permanent appearance presented by the Milky Way with the fact of its being only a local phenomenon, may have operated to deter anyone to whom the idea may have occurred, from pursuing it to its successful issue.

There is, however, one simple fact which is always before us, and which proper consideration will show is one demanding special explanation. This fact is the extraordinary individual brilliance of the Milky Way stars of all ranks under circumstances so unfavorable to individual brilliancy.

This is a point which somehow seems to have escaped notice that it is quite an anomalous feature, in view of the brilliant surroundings of all the stars in the Milky Way. Under the ordinary conditions affecting bright objects, their brilliant surroundings should be prejudicial to the brilliance of each individual star comprised in the bright company, and as we see exactly the opposite result presented to us, there is clear evidence here of some exceptional influence being at work on this part of the sky. The more the point is considered the more evident does this become, and it is strange in the extreme that it can have so long escaped recognition.

It suggests the clue to the Milky Way mystery which will cease to be a mystery if it be only studied in the light of common sense and without undue deference to the speculations or theories which have been put forth about it.

I have endeavoured by repeated references to it to lay stress on this point of the anomalous individual brilliancy of the stars in the Milky Way, in the hope of attracting notice to it, and I have gone the length of meriting the charge of "damnable iteration" in striving to induce astronomers to consider the point, as it is one which cannot be set aside or explained away by any knowledge we possess about the stars.

The Milky Way is simply the result of our viewing its portion of the sky through a special density of our local environment of darkness. It is a reproduction in the heavens of the Sun's apparent path round the earth. If the Sun's path be taken to represent by day the central line of sunshine, it will also naturally represent by night the central line of darkness.

The Sun's apparent path round the earth reaches points about $23\frac{1}{2}$ degrees north and south of the Equator. If we analyse the features of the Milky Way circle we find that it can be divided into four sections, two end sections exactly similar to each other, and two side sections also corresponding with each other. The end sections represent a distance of $23\frac{1}{2}$ degrees north and south of the Equator, or the outline of the Sun's path at either end of the earth. The side sections of the circle represent the outline of the Sun's path on each side of the earth, one side being north of the Equator and the other side south of it as shown in the diagram given in the Supplement.

If all the evidence I set forth receives due consideration it is difficult to see what more can be needed to prove that the Milky Way is merely a local phenomenon. Examination of the position of the luminous stream as seen from different parts of the earth may, however, show variations which would supply further confirmation. Some evidence on this point is given in the book on the Milky Way.

J. L. ADAMS.

Sydney, 28th July, 1906.

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A SUPPLEMENT

TO THE BOOKS

"THE MILKY WAY"

AND

"THE INFINITY OF THE STARRY UNIVERSE"

BY

JOHN LOWRY ADAMS.

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PREFACE.

This Supplement to my books "The Milky Way" and "The Infinity of the Starry Universe," is intended to supply for general information, a summary of the evidence in support of my contention that the Milky Way is simply the result of our looking at its portion of the sky through a specially dark part of the atmospheric envelope through which we view the heavens. The Summary is intended for the reader of ordinary intelligence, who has no special astronomical learning that is much beyond the average knowledge of reading men, and to such, I think, the plain commonsense explanation of the Milky Way which I put forward will appeal.

The supplement corrects some errors in the book, especially in the description of how the special darkness is produced which results in the Milky Way. It is, therefore, desirable that the supplement should first be read and then the evidence detailed in the book can be considered.

The Milky Way has long been a mystery to astronomers, and various theories have been put forward as to its meaning; but when we think of the great intelligence which has undoubtedly been bestowed on the study of everything connected with the heavens, the mystery which will attach to the Milky Way in the near future, will be how the simple solution of it, which is offered in these pages, could so long have evaded discovery.

"The Infinity of the Starry Universe" deals with a theory, the theory of the non-extinction of light in traversing space, which has been accepted by astronomers, and is commonly quoted as indisputable proof of the finiteness of the Starry Universe. The theory is supported by a mathematical demonstration, and I point out the fallacy in this demonstration. It is not necessary that the reader should be a mathematician to enable him to follow my exposure of the fallacy.

The book also supplies some diagrams and some further evidence in support of my contentions about the Milky Way, and indicates the importance of a recognition of the true character of the Milky Way in considering the question, Is the Starry Universe finite?

Sydney, 31*st May*, 1906.

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A SUPPLEMENT

TO THE BOOKS

"THE MILKY WAY"

AND

"THE INFINITY OF THE STARRY UNIVERSE"

BY

J. L. ADAMS.

THE MILKY WAY.

My contention that the Milky Way is simply a local phenomenon, being the result produced by our looking at its portion of the sky through a specially dark medium, has not met with acceptance because, so far as I can learn, my explanation of how the special darkness of the medium arises is regarded as quite inadmissible. My explanation is that a specially dark part of the Earth's shadow is the medium by which the effect is produced.

I have received, so far, only one written reply to my contention and it is expressed thus:—

"The idea that the Earth's shadow has a local connection with the Milky Way cannot hope to be accepted by astronomers and physicists."

No reference is made to the evidence I adduced in support of my contention that the Milky Way is a local phenomenon, and I am left to conclude that it is all disregarded because my explanation of how the effect is produced is unsatisfactory.

I am aware that another gentleman of considerable astronomical experience has stated that "the Earth's shadow can have no effect on our view of the stars because it does not reach them." Answering this latter objection I pointed out in my book on the Milky Way that merely local conditions such as sunlight, twilight or moonlight, according to their degree, undoubtedly affect our view of the stars, and that therefore a local envelopment, varying in its darkness, would produce the varying brightness we see in the sky; the brightest part, the Milky Way, being represented by the darkest part of our local envelopment. My arguments are, however, without success so far, and all the evidence which seems

to me to point so clearly and irresistibly to the conclusion that the Milky Way is only a local phenomenon, appears to be set at naught owing to a failure to realise how the special darkness which causes it is produced, a special darkness which I have spoken of as a special shadow effect. If, while substantially correct, it be technically inaccurate to describe the cause as a special shadow effect, this ought not to have prevented astronomers of experience from realising correctly how the special darkness can be produced, and I have, therefore, now to offer an explanation of this difficulty.

When night comes darkness sets in. The darkness is the result of our being protected from the sun's light by being in the shade or shadow of the earth. The earth is thus a physical obstacle interposed between us and the sun's rays. But why does darkness set in after sunset? Is it not that darkness must be the condition in space around us, and when the sunlight which interferes with this condition is withdrawn then darkness ensues? If this be not so then where does the darkness come from? I do not suppose it will be denied that darkness is the condition which necessarily ensues in the absence of sunlight or reflected sunlight, such as twilight or moonlight, and it will then at once be evident that this darkness is the darkness of space around us and must extend to the stars. We do not derive the darkness of night from the earth's shadow except that through being in it at the earth, it protects us from sunlight, and it is then of no consequence how far the shadow extends into space, because the darkness around us is the medium through which we look at the sky, and this darkness is a part of the darkness which extends to the stars. This latter darkness, the darkness of space outside or beyond our immediate envelopment, will be at least as dark as the darkest portion of our envelopment.

With this fact clear, and as we have proof constantly before us that what are merely our local conditions, as the degree of twilight or moonlight, affect our view of the stars, it surely follows that the varying darkness of our local envelopment will, in effect, be reflected in the varying brightness of the stars seen through it, and a further result will be that more stars will be seen when the conditions are favorable for their being brought into view.

That we have a varying darkness in our ordinary local envelopment is evident when we remember that even at night the sunlight is close around the earth and the sun's rays are reflected by the atmosphere, giving rise to the twilight. This twilight we also know is greatest at the polar regions of the earth, and gradually diminishes towards the tropics. As the resulting varying darkness in our local envelopment will affect the view of the sky seen through it, we should then expect the brightest part of the sky to be opposite the tropical regions of the earth. Now, the Milky Way is a reproduction with a modification of the sun's apparent path round the tropical regions and, therefore, also of the

effect produced by the sun in the course of his apparent path round the earth. The modification spoken of is equivalent in result to an extension of the sun's path beyond the solstitial points, and will be described more fully later.

The correspondence of the Milky Way with the sun's path is indicated by its connection with the ecliptic at the two turning points in the sun's path known as the Solstices, which represent the northern and southern termini of his annual journey. These two points are opposite two points in the sky in the ecliptic constellations of Gemini and Sagittarius. Consequently we see these points in Gemini and Sagittarius on opposite sides of the sky to each other at midnight of the equinoxes, at equal distances apart from the equinoctial point, the earth's centre; and at midnight of the Solstices these two points are each in turn seen in the sky in the meridian. Is all this to be dismissed as merely strange coincidence?

The facts just quoted show that the earth is exactly in the centre of the Milky Way circle with the result that the Milky Way circle is only a circle when viewed from the earth. A view from the vicinity of a neighbouring star would eject from the circle stars seen in it from the earth, while introducing into it other stars which as we see them are far outside it. Instances of this transposition are given in my book and could be multiplied ad nauseam.

The Milky Way zone in the sky is regarded by astronomers as a special region or zone of the heavens. Its special character is derived solely from the unusual brightness of its stars and their unusual number. The result of the earth being in its exact centre is the strange circumstance that this so-called special region of the heavens closely encircles the earth like a huge wedge with its edge pointed to the earth on every side, with a width near the earth altogether insignificant, but gradually growing wider and wider as it extends away till it reaches in the far distance an average width of considerably over a thousand light years. What can explain the existence of such an extraordinary special region of the heavens except the simple fact that this huge wedge is the creation of an influence emanating from the earth as its centre, and radiating from it into space, growing seemingly wider and wider as it extends, because it includes the nearest and the most distant stars in the one embrace. The Milky Way zone, according to some estimates, contains more stars than all the rest of the sky, although the total in the whole sky is estimated at hundreds of millions.

If such a vast region of the heavens do not merely represent an arbitrary annexation by the earth by means of a special glamour exercised upon our view of it, why should our little earth have been selected to be its central point—its hub? Why should we have been singled out for this special distinction accorded to our dwelling-place?

That it is the central point of the apparent circle in the sky called the Milky Way is clear from the earth's position in regard to it, as well as from the other evidence which shows that it is only a circle when viewed from our position in it. I do not, of course, contend that the earth is in a central position with regard to the stars included in the Milky Way circle, but simply that it is the centre of the illusive circle itself.

Then there is the peculiarity of the special brightness of the individual stars in the Milky Way. This superiority in individual brightness is well known, but it does not seem to have been noticed that it is an anomalous condition in view of their brilliant surroundings and bright background. It is only evading the real point at issue to say that the superior brightness of the Milky Way is owing to the great number of stars in it. This does not in any way account for the individual brightness of each star amid such brilliant surroundings, but makes it, in fact, more extraordinary. Does a lamp shine out more brightly when alongside other bright lamps than it would among inferior ones, or with no rivals near it? Do lamps or lights of any kind—and stars are simply great lights—borrow brightness from each other, to their mutual advantage? And do lights shine out more brightly with a bright background behind them than they would without it? A little consideration of this feature of the Milky Way stars —which has passed unnoticed apparently, as I find no allusions to it in anything I have read about the Milky Way —will show that in such brilliant company it is most strange that each star should shine out so brightly as compared with the generality of stars in other parts of the sky, which have no such brilliant surroundings or bright background to contend with. This single feature of the Milky Way is enough of itself to arrest attention and demand explanation of its seeming anomaly. Of the 14 stars which are the brightest in the heavens no less than 12 are in or near the Milky Way. Of the next order of brightness 18 out of 29 are in or near the Milky Way. Down to the 4th magnitude there are 121 Milky Way stars out of a total of 228 for the whole sky. This superiority extends through all ranks of stars in the Milky Way down even to the background, which shows out brightly also in spite of all the special brilliance in front of it.

And then the stars nearest this bright mass of light should have their lustre decreased by contrast with it, but exactly the opposite condition prevails; the stars nearest the Milky Way are brighter individually than those farther away and are also more numerous in proportion to the area of sky occupied.

As there is nothing special in the constitution of the Milky Way stars to account for the extraordinary superiority in brightness they possess under conditions so unfavorable to individual brightness, and they are not specially near to us, it will become evident on due consideration that they must be subject to some

special influence to produce the result seen. What could be the nature of such an influence except that we see them through a medium of special darkness? I have mentioned the fact, of which I have given illustrations in my book, that a change in our point of view would bring some stars out of the Milky Way circle and introduce into it others which are now outside it. Would the stars so ejected retain their special brightness, and would the strangers be endowed with a share of the Galactic lustre on their entry into the magic circle?

When we bear in mind that the individual stars of the Milky Way are specially bright, and that owing to our earth being in the exact centre of the Milky Way circle, it is only a circle when viewed from our position in it, and that a change in our position would eject some bright stars from their specially bright circle and introduce some dull strangers into it; I cannot too strongly assert that these facts alone, if given due consideration, should be conclusive proof of the local character of the Milky Way circle. It is quite easy to verify my statement as to the change which would take place in the relative positions of the stars if we could see them from some new point of view. I may, however, give an illustration here of another sort to show what is the real value of our proud central position in the Milky Way in the eyes of any neighbours of ours in space.

Our earth as seen from the distance of any star is close alongside the sun. The equinoctial line will pass through the earth and sun, and if we imagine it extended to points 20 light years away from us on either side, it would reach point No. 1 in the Milky Way circle between Sirius and Procyon, and about 10 light years beyond them on one side, and on the other side it would reach point No. 2 in the constellation Aquila, south of and about 6 light years beyond Altair. Now an observer at point 1, looking for the sun along the equinoctial line would see him apparently in the constellation Aquila, close to Altair, and therefore on Aquila's side of the Milky Way circle. On the other hand an observer at point 2 would see the sun close to and between Sirius and Procyon, and therefore on the opposite side of the circle. Our sun, or our sun and earth together, have thus a circle of their own which is not open to recognition from outside their own vicinity. It cannot however be denied that they have a legitimate title to its exclusive enjoyment seeing that it is a circle entirely of their own making.

If we study the character of the Milky Way circle as it is shown in figure 1 of the book I think its connection with the earth will become very clear.

For convenience of reference I reproduce the figure with this supplement. I have also marked the positions of some of the constellations of the circle. The solstitial points are marked G and S (for Gemini and Sagittarius) and P.N. and P.S. are the points north and south where the line P.P. touches the earth. The feature which first strikes one on looking at the Milky Way circle is

its great length along the line P.P. which reaches a point in Argo 47 degrees beyond Gemini at one end and a point in Cygnus 47 degrees beyond Sagittarius at the other end, thus reaching in each case a point a little more than half-way between the solstitial point and the succeeding equinoctial point.

The width *across* the Milky Way circle is greatest along the line of the equinoctial or the equator, but the width across the ecliptic is comparatively short.

It will be noticed that from the ecliptic at Gemini to Cygnus on the north side of the Milky Way there is a section which is identical in length and direction with a section on the south side from Sagittarius to Argo, and the section from Gemini to Argo has also its counterpart in the opposite section from Sagittarius to Cygnus.

Now if we endeavour to form an idea of the effect which would be produced on the distant sky by the position of the earth and the column of density at various parts of the earth's orbit we will be able to arrive at an explanation of the shape of the Milky Way; but we must first consider the position on the earth of the central column of sunshine which corresponds with the column of greatest density. The earth, in travelling along the sun's apparent path from Gemini to Sagittarius brings the sun gradually northward along the line of the ecliptic from G. to S., and on her return journey the sun is brought along the same line from north to south. At any time during the year there is then a part of the earth, on the side towards the sun and on the line between G. and S., where the sun is central, and from this centre the sunshine will extend in all directions.

The centre of sunshine is, however, always on the ecliptic in the middle of the sun's apparent path, as it appears at the equinoxes, though the centre apparently travels more north or south on the earth owing to the varying inclination of the earth at the different seasons.

The centre line of sunshine thus always extends along the line G. to S. (the sun's path), and its extent north or south depends on the inclination of the earth.

There is a corresponding column of density on the side of the earth away from the sun, with its centre corresponding to the central line of sunshine. The centre of density will, however, be thrown more south as the centre of sunshine is thrown north and vice versa.

As the earth's orbit is an ellipse there are portions of it where the earth will be travelling longer in nearly the same direction than she will at other parts of her journey. These portions are towards and from the equinoxes. If we look at the figure we will see that the twin sections from Gemini to Cygnus in the north, and from Sagittarius to Argo in the south, represent these portions of the orbit. Points in Cassiopeia and Crux represent the distance from either end of the equinoctial points.

When the earth has passed the portions of her orbit just referred to she is, of course, nearing one end or the other of her six months' journey and is turning round to return. Her course round her orbit brings her past Taurus before Gemini on one side, and past Scorpio to Sagittarius on the other. We will suppose she has reached Taurus after coming from Cassiopeia. As far as Taurus the direction of her journey is indicated by the curve from Cygnus round through Cassiopeia representing the part of her journey when she has been more or less broadside to the sun, but between Taurus and Gemini is the solstitial point, where she begins to turn round in front of the sun for her return voyage. Opposite Argo she has turned back towards the sun and from Argo she is travelling towards Sagittarius in a similar curve to that on the north side from Cygnus to Gemini. From between Scorpio and Sagittarius she turns inward again in the direction of Cygnus, which is the turning point for the return journey.

We have thus what may be called a side view of the earth's course from Cygnus to Gemini on one side and from Argo to Sagittarius on the other, and when she is turning from Gemini to Argo, or from Sagittarius to Cygnus, we are presented with the front view which is a reflection in the sky of the outline of the column of density round the farther side of the earth from the sun while she is turning round.

The great length of the Milky Way circle compared with its width is explained by the fact that after passing the equinoctial points, the earth is receding from the sun towards each end of her orbit, and the sunshine is accordingly thrown more and more ahead of her as she travels. The line P.P. divides her yearly journeys to and fro into two equal and similar semicircles, and it represents an extension at each end to a point which is 23½ degrees above the equator on one side and 23½ degrees below it on the other.

The earth's journey as regards her position relative to the distant stars is practically nothing but a revolution close around the sun. A side view of the Milky Way from a point on the equator at the time of one equinox, and a front view at the following solstice, will represent also in their general character and position relative to the earth, the views at the succeeding equinox and solstice, when the earth is on the opposite side or end from the sun. Figures 8/11 of the book on the Milky Way give views of the circle at the times of the solstices and equinoxes. These are made up from maps of the sky for northern and southern latitudes. In figure 8 (the March equinox) the equinoctial point on one side is represented in Cassiopeia, the culminating point of a semicircle, with the other equinoctial point in the centre of the arc to the south in Crux.* In figure 9 (the September equinox) we have a similar view reversed. In both cases the solstitial points in Gemini

*In speaking of the equinoctial points as represented by points in Cassiopeia and Crux, I mean as regards their distance from the solstitial points. They are, of course, on a different plane.

and Sagittarius are opposite each other at the sides. In the end views, 10 and 11 (the solstices of June and December) the pictures are again identical, with the difference that the centres are occupied by each solstitial point in Gemini and Sagittarius in succession, with their neighbouring constellations. These views alone are enough to indicate the local character of the Milky Way circle and its intimate connection with the earth, which they show to be in its exact centre, as they are views of it from four different cardinal points, viz., the equinoctial and solstitial points, of the earth's journey round the sun.

Let us consider the position of the earth in its relation to the Milky Way at the time of the solstices as shown by the diagram herewith.

In December the earth is opposite the solstitial point in Gemini and the sun is behind her between her and the solstitial point in Sagittarius. The South end of the earth is inclined towards the sun and the North end, opposite Gemini, is depressed away from the sun. The sunshine extends on either side of the earth from the direction of S. (Sagittarius) in the direction of G. (Gemini.) On Gemini's side of the earth the corresponding line of density extends round the earth with G. (Gemini) in its centre, and is represented in the Milky Way extending south from Gemini through Argo and Crux, and north from Gemini through Cassiopeia, terminating at Cygnus, as shown in figure 11 of the book. At this time the point S.P. on the earth represents on the Gemini side of the earth the point S. on Sagittarius' side, because, as the earth revolves parallel with the equator, it is the point which as the earth revolves will be brought opposite the sun, viz., to S. The point S.P. is $23\frac{1}{2}$ degrees below the equator as the point S. also is, and the point in the Milky Way in Argo reached by the line P.P. represents the same distance below the equator.

In June the position is similar, but reversed. Sagittarius is now the centre of the column of density represented in the Milky Way going on the north side round by Cygnus and Cassiopeia, and on the south side through Crux and terminating at Argo, as shown in figure 10 of the book. The point N.P. will represent on Sagittarius' side of the earth the position of G. (Gemini) where the sun is central, and N.P. is represented in the Milky Way where the line P.P. reaches Cygnus.

The line P.P., which represents the centre of density, extends to a distance of $23\frac{1}{2}$ degrees north of the equator on one side and $23\frac{1}{2}$ degrees south of the equator on the other. It reaches a point in Argo at one end of the Milky Way circle and a point in Cygnus at the other end. It is the mean between the sun's path on either side of the earth, and is the centre line accordingly of the columns of density on either side, and also the centre line of the greatest length of the Milky Way circle. The great length of the circle is owing to the fact that the earth is receding from the sun after

passing the equinoctial points, and the effect of the column of density is thus gradually thrown ahead of the earth. This continues while the earth is turning round, after passing the solstitial points, for her return journey, and until she has passed the points in Argo and Cygnus marking the ends of her outward journey. The sections between Gemini and the Argo turning point, and between Sagittarius and the other turning point in Cygnus, represent each a distance of 47 degrees, being the distance of the turning points above and below the equator on either side, added to the distance of the equator above and below the ecliptic on either side. The end sections of the Milky Way represent, then, a distance of 47 degrees each and the side sections a distance of 133 degrees each as shown by the parallelogram in the figure.

On the north side of the Milky Way the section from Gemini to Cygnus represents in its general direction a curved line $23\frac{1}{2}$ degrees above the equator. On the south side the twin section from Sagittarius to Argo represents a similar line $23\frac{1}{2}$ degrees below the equator. At Gemini's end there is accordingly a fall of twice this distance, or 47 degrees, between Gemini and the point P. in Argo, and at Sagittarius' end there is a rise of 47 degrees to the corresponding point in Cygnus.

The earth's journey round the sun may be described as resolving itself into two main features, a nearly straight run on either side with a short turn round at each end, and these features are reproduced in the Milky Way.

With all the evidence before us serving to show the intimate relationship between the Milky Way and the earth, and when we consider that all the puzzling peculiarities of the Milky Way are quite intelligible as the results of its being seen through a special darkness; it is difficult to imagine what more can be needed to convince any reasonable mind of the local character of the Milky Way, and that it is simply the result of an influence emanating from the earth. If my description of how the darkness which results in the Milky Way is produced be still thought unsatisfactory, some other explanation ought surely to be put forward by those better qualified to do it. I am amenable to correction in this particular respect, or in regard to any other errors I may have been led into, but whether my explanation of the nature of its origin be accepted or not I am unable to conceive what further evidence is necessary to prove that the Milky Way is entirely a local product, and that its circle has as much reality, as a circle, as has a rainbow or a halo round the moon, though its greater permanence may help to disguise the fact.

To realise my idea of how the Milky Way is produced, one must imagine our atmospheric envelope, through which we look at the sky at night, to be of varying degrees of darkness, owing to the reflected sunlight, called twilight, which is greatest at the poles and diminishes gradually towards the tropics, where it is

absent. This twilight accordingly acts as a sort of curtain of brightness, and veils, according to its degree of brightness, our view of the stars. The veil is removed over the tropical regions and we get accordingly a glimpse of the sky there, which is as a revelation suggesting the glories we would see all around us in the sky everywhere if the veil were wholly instead of being only partly lifted.

Some correction will be necessary for my book on the Milky Way consequent on my amended explanation of how the special darkness occurs which results in the Milky Way.

The line P.P. in figure 1 is the central line of the circle of the Milky Way, and represents an extension of the sun's apparent path at either end of the earth's orbit, in consequence of the sunshine, and therefore also the column of density, being thrown forward as the earth recedes from the sun. It represents also the centre line between the travelling columns of sunshine and density on opposite sides of the earth.

On page 15 it is stated that the sunlight is, of course, all round the earth's shadow in every direction between it and the stars. This is not correct. The sunlight is limited to the immediate neighbourhood of the earth. The same limitation is to be applied to the other statements to like effect in the same paragraph.

I regret the error and can only plead by way of excuse that I was led into it to some extent by the misleading descriptions (unintentionally misleading, of course) of the earth's shadow, which appear in astronomical and other scientific publications. As the phenomena connected with eclipses are apparently so well understood that eclipses can be predicted with the greatest accuracy: it is natural that one should study any authoritative explanations of how eclipses occur, with an absolute freedom from any feeling of scepticism as to the perfect reliability of these explanations. It was here that I was misled, and it is a warning that one can never absolutely depend on human infallibility, even though we may know that men of the highest intelligence have dealt with the matters in question. This is a somewhat depressing view to take of the perils which are always threatening, but it is nevertheless a fact which applies generally to our experiences in life, that unceasing vigilance must be exercised to escape disasters. We must keep our eyes open even when the coast seems perfectly clear—at least until we arrive at Utopia.

Before writing my book on the Milky Way I naturally desired to know as much as possible about the earth's shadow, the umbra and attendant penumbra. In Chambers' Encyclopedia (1868 edition) in the article on eclipses there are diagrams to illustrate the descriptions of how eclipses occur, and the umbra and penumbra are depicted in their different grades of darkness—

Then the article tells us in one place:—

"In the foregoing explanation we proceeded on the assumption that the earth has no atmosphere. If the assumption were

correct the *earth's shadow would be darker and narrower* than it is," &c., &c.

And again—

"Accordingly the moon which, as we have seen, crosses the shadow at a distance of about 60 radii, never enters *that part of it which is completely dark*," &c. The article further says "*that every shadow cast* by the sun's rays has necessarily a penumbra, or envelope on both sides of the shadow." And in the article on the penumbra we are told—"The shadow of the earth *thrown by the sun upon space* at the moon's distance gives a penumbra many times as large as the umbra."

Then again in "The Heavens," a hand-book of popular astronomy, by Amedeé Guillemin; edited by J. Norman Lockyer, and revised by R. A. Proctor, we read that both the earth and the moon "*throw behind them*, away from the sun, shadows of conical form," and, in regard to the penumbra "every part of space in the penumbra only receives light from one part of the sun," and "*the darkness produced by the penumbra* is so much more intense as the point is nearer the umbra."

These descriptions are, of course, correctly representative of what we have all been taught in our school-boy days about the earth's shadow; but it is not, I think, unreasonable in view of these descriptions and their accompanying diagrams, that one should be led to form an idea of a shadow attached to the earth as a sort of visible tail extending out into space, having the penumbra somewhat darker and the umbra still more dark than their surroundings in space; and having thus a visible dark entity separate from the less dark space around, and also varying in its own darkness. I think this idea of the earth's shadow, which presented itself to my student mind and remained unchanged after later study, may also have been the idea in the minds of some, if not of all my critics, because although I contended that all I required for my shadow effect to produce the Milky Way was merely a local environment of special darkness, some of my critics objected that the shadow could have no effect unless it reached the stars. The other reply made to me that "astronomers and physicists could never accept the idea of a local connection between the shadow and the Milky Way," also suggests that the same notion is implied of a necessary great extension of the shadow before any effect could be produced, although in this latter case the objection was made by one thoroughly at home in all points connected with the shadow and with calculations as to eclipses.

As I have pointed out that the darkness which ensues when night sets in is evidently the darkness which must be the condition of space around us, and as the sun's rays are, of course, travelling through space in every direction, it follows that the mere presence of the sun's rays anywhere does not cause light unless the conditions also exist which bring the rays into operation. On

the other hand the absence of the sun's rays does not cause darkness in space, or any greater darkness than is the ordinary condition of space. Neither the umbra nor the penumbra then will be darker than the space around them.

If it be asked how then does the moon become darkened when she enters the earth's shadow, the answer will be, of course, that before entering the shadow she is exposed to the full illuminating influence of the sun's rays, which only come into operation on reaching the moon, but after entering the shadow she is more or less protected from their action, the protection being more complete when she enters the umbra than it is in the penumbra.

In the third paragraph on page 17 of the book on the Milky Way commencing "If we extend" I make a mistake in saying "it would divide the Milky Way *midway* between the points in Gemini and Sagittarius." Of course, any line drawn across the circle and passing through its centre will divide the Milky Way circle equally. As the centre is the earth it follows that any line passing through the earth's centre to any parts of the Milky Way circle will divide it equally.

My amended explanation of how the darkness around us must extend also to the stars will probably make clearer how it is we are able to see the Milky Way in the west soon after sunset, or in the east shortly before sunrise, an explanation of which is given in pages 14/15 of the book on the Milky Way.

THE INFINITY OF THE STARRY UNIVERSE.

This book deals with a theory, the theory of the non-extinction of light in traversing space, and points out its unreasonable character. The theory is usually relied on to show that the starry universe around us must be finite. The book also gives further evidence in support of my contentions about the Milky Way, with some diagrams to illustrate the impossibility of our being able to see in all its proportions any circle round the starry universe such as the Milky Way is taken to be. This also helps to show the necessarily local character of the Milky Way circle.

Any references in the book to light in space must be read to mean light currents under conditions ensuring visibility.

CONCLUSION.

Finally it may be well to again impress on my readers that the extraordinary individual brilliance of the Milky Way stars in general, as compared with stars in other parts of the sky, is a fact demanding special notice and consideration. Their superior brilliance has, of course, been noted by astronomers, but what has not been noticed is that this individual brilliance is altogether abnormal or anomalous under circumstances of general brightness, around, behind, or in front of each star, which should

be so unfavorable to individual brightness. The brightness of each star under such unfavorable circumstances would require to be very great to enable it to retain even an equality with stars less unfavorably situated, as are the stars in other parts of the sky. To show superior individual brightness then under such unfavorable conditions suggests, when the matter is properly considered, that there must be some special influence at work, because there is nothing in the constitution of the Milky Way stars to explain their special brilliancy, nor are they specially near to us. On a clear moonlight night when few stars are visible in the sky elsewhere, the course of the Milky Way is plainly indicated by the number of its lucid stars visible; and when we consider the mass of brightness which is around and behind all these lucid stars, and yet in spite of all this brightness in front, the background is also visible in places, composed of stars immensely distant; I am unable to understand how it can have escaped recognition that there is clear evidence here of some special influence being at work on this part of the sky.

Reflection on this point furnishes the clue to the mystery of the Milky Way, for notwithstanding the imaginative speculations of astronomers it is a mystery, and will remain so till theories about it are discarded and the simple solution which is before us is reached by deductions based on observation and common sense.

NOTES FOR DIAGRAM.

N.P. and S.P. are the points where the line P.P. touches the Earth in the north and south respectively. G. indicates the Gemini Solstitial point on the Earth and S. the Sagittarius Solstitial point. The column marked by the dotted lines from G. to N.P. down to S. and back by S.P. to G. represents the tropical regions, extending about $23\frac{1}{2}$ degrees north and south of the Equator. The line P.P. divides this column equally along its greatest length, as it does also the Milky Way circle.

The 47 degrees of tropical region, at each *end* of the Earth are represented in the Milky Way from Gemini to Argo, and from Sagittarius to Cygnus, leaving 133 degrees for each *side* from Gemini to Cygnus, and from Sagittarius to Argo.

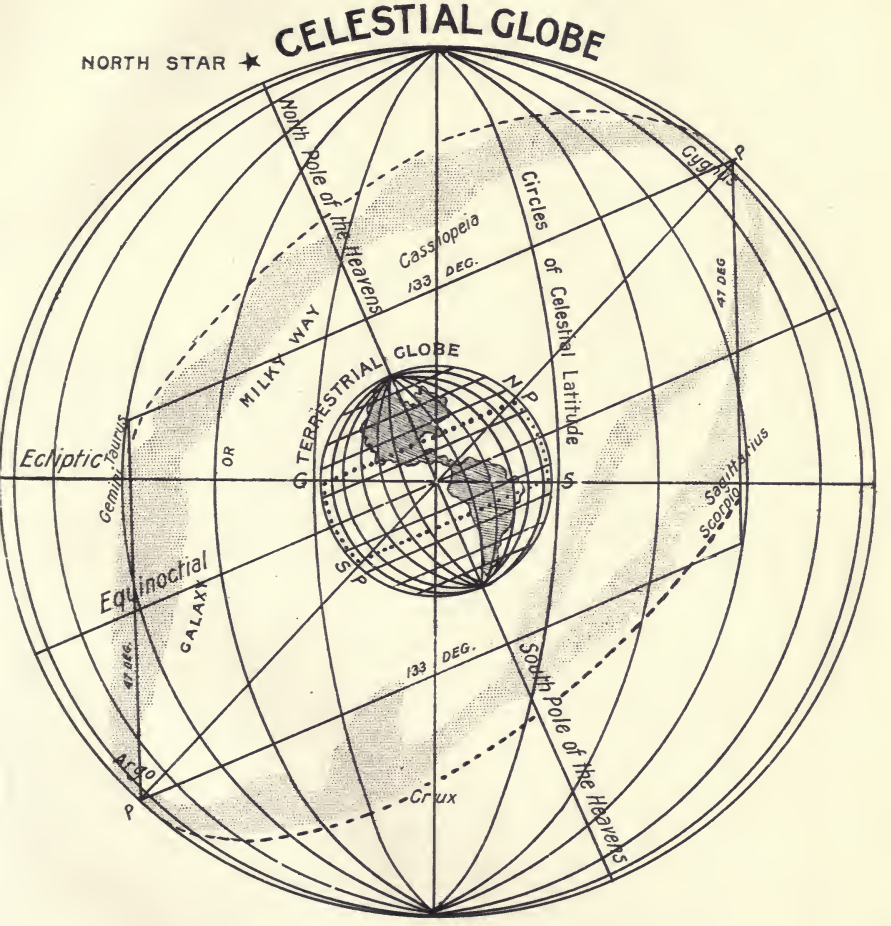
The Milky Way on the north side represents a slight curve outward from Gemini to Cassiopeia and inward from there to Cygnus, and on the south side a similar curve outward from Sagittarius to Crux and inward from there to Argo. At the ends the curve is more inward from Gemini to Argo, and from Sagittarius to Cygnus. The dotted lines show the curves of the different portions of the side sections.

The vertical line in the diagram represents the line of the Equinoxes crossing the Ecliptic at right angles.

The side lines of the parallelogram are marked to represent 133 degrees, but the side sections of the Milky Way do not correspond in apparent length with the 47 degrees represented in each end section, because the effect of the column of density is always produced along the one line round the sky, and is thus being continually repeated along that line. It is not therefore extended proportionately to the length of the earth's journey.

The side sections of the Milky Way more nearly represent the outline of the sides of the earth, say from G. to N.P. on the North side, and from S.P. to S. on the South side, as the end sections represent the outline of the portions of the earth between G. and S.P. and S. and N.P.

Fig. 1.


CELESTIAL GLOBE
NORTH STAR
North Pole of the Heavens
Cassiopeia
133 DEG.
Circles of Celestial Latitude
Cygnus
47 DEG
MILKY WAY
OR
GALAXY
TERRESTRIAL GLOBE
N P
S P
Ecliptic
Gemini
Taurus
Equinoctial
Sagittarius
Scorpio
133 DEG.
47 DEG.
South Pole of the Heavens
Argo
Crux

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THE MILKY WAY.

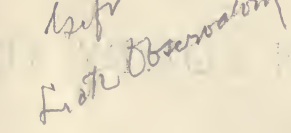
THE SOLUTION OF THE PROBLEM OF THE MILKY WAY, SHEWING IT TO BE A SPECIAL SHADOW EFFECT.

BY

JOHN LOWRY ADAMS.

1671

SYDNEY:
Turner and Henderson, Printers.
1905.



INTRODUCTION.

As I am not an astronomer some explanation is necessary why I am writing a book on an astronomical subject. Even but a year ago nothing could have appeared to me more improbable, but it is the unexpected that always happens, and I am the victim of circumstances.

In 1903-4 there had been much discussion on Dr. Wallace's book, "Man's Place in the Universe," and in April, 1904, I had been reading Professor Newcomb's most interesting work, "The Stars, a Study of the Universe," which Dr. Wallace had taken as a support for some of his arguments. The stress laid upon the Milky Way and its position in the starry universe attracted my special attention, and I took to observing it in the heavens and reflecting on its peculiarities.

The first idea which seized on me and grew stronger as I pondered on it, was the impossibility of our being able to see in all its proportions, a circle so inconceivably vast and distant as to practically form a ring round the whole starry universe. When we try to think of the distance represented by one light year; that is, the space traversed in one year by light, travelling at the rate of eleven million miles a minute, or 660 millions of miles an hour; and find that the nearest star to us, α Centauri, is $4\frac{1}{3}$ light years away; and then that of the millions upon millions of stars in sight and revealed by telescopes, less than a hundred are near enough to be measured, while some of these are at distances representing over a hundred light years, and an immense majority of those unmeasured must be at gradually increasing distances beyond this, and therefore going on to even thousands of light years; it not only is incredible that we could have in full view a complete circle extending round the starry universe, but to my mind it is impossible that we could see even the smallest arc of any such circle.

It then occurred to me that what we were looking at in the Milky Way must be some sort of shadow effect, but how was it produced? My discussions of the matter with a few acquaintances in astronomical circles did not impress them favourably, but I

continued to study the subject till I became convinced from the evidence before us that the Milky Way was a product of the earth's shadow. The difficulty presented itself that the Milky Way did not agree in position with the known centre of the earth's shadow. I was, however, in hopes that some one more experienced than I was in astronomical matters might be induced to take the subject up, and I thereupon prepared a paper indicating the evidence which I thought strongly pointed to the Milky Way being a shadow effect, and submitted it to several gentlemen connected with an astronomical association. My ideas, however. did not find support, and, as I realised that, except in one instance, my notions about the Milky Way were only the subject of amusement to the better informed, I had to take the matter in hand myself, and I was eventually enabled to find the solution of the variation of the position of the Milky Way from that of the centre of the whole shadow of the earth. The solution is presented in this book; and is in effect that there is a shadow within a shadow, each having its different centre.

The trespasser in any carefully cultivated, and closely guarded, scientific field will be sure to find pitfalls, great and small, waiting for him on every side. The knowledge of this, and of my poor equipment, being only a raw recruit in the astronomical ranks, for any conflict with the recognised guardians of the astronomical field, led me to hope that I might be spared this ordeal; but the burden has been cast upon me and if, with all my caution, I have been unable to avoid some of the traps for the unwary among which I have been plodding my way, I shall view the detection and exposure of any slips with a reasonable degree of equanimity, in the sure and certain faith that my main contentions are unassailable, and that the more the subject is studied the more clearly will it become evident that in the Milky Way we have before us what is nothing more or less than a local phenomenon, a special shadow effect.

THE AUTHOR.

SYDNEY, *May, 1905.*

THE MILKY WAY.

CHAPTER I.

DESCRIPTION AND GENERAL FEATURES OF THE "MILKY WAY."

BEFORE proceeding to consider the question as to what the Milky Way is in reality, it may be well to give first a general idea of its features, and I cannot perhaps do this better than by quoting the description of it which is given in the introduction to the popular map for the Southern Hemisphere, entitled, "The Constellations and How to Find Them," by Mr. W. Peck, F.R.A.S.

Mr. Peck's description is as follows:—

"THE MILKY WAY.

"On any dark, clear night, when there is no moon, a large band of cloudy light will be seen stretching right across the heavens from one side to the other This is called the Milky Way. The position of this luminous zone in the sky, for any particular time, will be found by referring to the monthly maps. In our southern latitudes it will be seen passing through, or near, the constellations Cygnus, Aquila, Sagittarius, Scorpio, Ara, Crux, Argo, Canis Major, Gemini, and Auriga. That part of its course extending from Canis Major to Auriga is exceedingly faint and regular in outline; while, on the other hand, the part which traverses the constellations of Scorpio, Sagittarius, Aquila, and Cygnus is more conspicuous, and in appearance it is very irregular. In the Ship, Argo, it will be observed that the brighter portion of the stream is completely divided by a dark and curiously shaped opening, and that near the Cross, it is very bright, though some of the luminous patches, seen in the constellation of the Archer, may be even more brilliant.

"When examined with a powerful telescope, the Milky Way, especially in those parts of its course where its appearance is very conspicuous, is truly a magnificent sight. Even with so small an instrument as an opera glass, the vast number of stars that are rendered visible, is well calculated to impress the least thoughtful mind with a sense of the Omnipotent power, and the infinite wisdom of the Creator, who brought so many *suns* into existence (for each of the many million stars seen in the Milky Way is a sun just like our own sun), so we do not wonder that, when the celebrated Schroeter was observing a part of

the galaxy near Arided (*a*) in Cygnus, with a reflecting telescope nineteen inches in diameter, he was so impressed with the infinite grandeur of the scene, that it drew from him the natural exclamation, 'What Omnipotence!'

"But even before the telescope was invented, the Milky Way had attracted considerable attention; in fact, centuries before that instrument was even thought of, ancient astronomers had watched the luminous band as it stretched across the heavens, and had even arrived at the conclusion that its milky whiteness would, in all probability, be produced by the combined lustre of myriads of stars, which being situated at such vast distances away, became individually indistinguishable; and thus Ovid says that 'It is a road whose ground-work is of stars,' and Manilius uses similar language.

"It was only, however, when Galileo first turned the telescope to the Milky Way that its true nature became known. That instrument revealed to him the glorious assemblage of stars of all orders of brightness; from those which appeared to him as bright as the leading stars in the heavens, down to the smallest visible point of light, which could only be but momentarily glanced at as they glittered like a sprinkling of diamond dust against the background of the sky.

"But there were some parts of the galaxy that Galileo's telescope utterly failed to penetrate, and there still remained in the background that same misty light which had for so many centuries engaged the attention of astronomers; though the telescope that Galileo possessed must have revealed to him an enormous number of stars compared to what he had only before seen with the naked eye. With every increase of telescopic power more stars were seen, and greater depths were reached, but only to find, as Galileo had found, that still some parts would require a more powerful instrument to reveal the individual stars that, by being so closely crowded together, caused this cloudy light. And even when Sir William Herschel applied his powerful reflectors—the largest of which was forty feet long and four feet in diameter—to this part of the heavens, and reached still farther depths, there was yet seen that same milky light which speaks of the myriads of stars still to be revealed. Nay, even Lord Rosse with his gigantic telescope—which is six feet in diameter and fifty-four feet long—could not resolve some of the luminous patches scattered throughout the Milky Way, though in some directions he penetrated vast distances into the infinite space, and saw stars so distant that the light from them must have taken many *hundreds* of years to journey to our earth, and travelling, too, at such a tremendous velocity that in a little over every five seconds it moves through a space equal to *one million* of miles. But though all the stars composing the Milky Way have not yet been revealed, still it has long been considered as demonstrated, that the milky light is caused by myriads of faint stars, and, in fact, it is as Milton describes:—

> "'A broad and ample road whose dust is gold,
> And pavements stars, as stars to us appear:
> Seen in the Galaxy that Milky Way,
> Like to a circling zone, powdered with stars.'"

What is exactly meant by the term "Milky Way" has here to be considered. Towards the end of the description just quoted, it is stated "that it has long been considered as demonstrated that the 'milky' light is caused by myriads of faint stars." It is the "milky" light here referred to which is, of course, responsible for the name, "Milky Way," but this milky light is confined to the background of the region of the Milky Way, and forms a sort of luminous stream composed of remotely distant stars. In front of this luminous stream are other and nearer stars of various degrees of brightness, including some which are among the brightest in the whole sky, and it is not the background alone of the Milky Way which is exceptionally bright. Exceptional brightness is also the characteristic of the lucid stars* in its foreground. On bright, moonlight nights when the luminous stream of the background is invisible, its general course across the sky will be seen plainly indicated by the lucid stars of the foreground, while only a few bright stars are visible in other parts of the sky.

The following quotation from Mr. J. E. Gore's contribution to the Concise Knowledge Library Book on "Astronomy" will show that this exceptional brilliancy is the general characteristic of the stars in the foreground of the Milky Way :—

"Let us now consider the apparent distribution of the stars and nebulae on the celestial vault, and their probable relation to each other in space. As already stated, Argelander considered the number of stars of the first magnitude to be about twenty, but modern photometric measures have reduced this number to thirteen or fourteen. According to the Harvard measures, the fourteen brightest stars in the heavens, in order of magnitude, are: Sirius, Canopus, Arcturus, Capella, Vega, Alpha Centauri, Rigel, Procyon, Achernar, Beta Centauri, Betelgeuse, Altair, Aldebaran, and Alpha Crucis. Seven of these are in the Northern Hemisphere, namely: Arcturus, Capella, Vega, Procyon, Betelgeuse, Altair, and Aldebaran; and seven in the Southern Hemisphere: Sirius, Canopus, Alpha Centauri, Rigel, Achernar, Beta Centauri, and Alpha Crucis, so that the brightest stars are pretty evenly distributed between the two hemispheres. Of these bright stars, no less than twelve lie in or near the Milky Way, Arcturus and Achernar being the

* *i.e.*, Stars visible to the naked eye, sometimes called "naked eye stars."

only two at any considerable distance from the galaxy. This is very remarkable and suggestive, as the area covered by the Milky Way is probably not more than one-fourth of the whole star sphere.

"Of the stars fainter than the first magnitude, but brighter than magnitude 2·0, there are about ten in the Northern Hemisphere, of which four lie in or near the Milky Way, and about nineteen in the Southern Hemisphere, of which no less than fourteen are situated in or near the Galaxy.

"Of those brighter than magnitude 3·0, I find 33 stars in or near the Milky Way, out of a total of about 95 in both hemispheres. To extend this investigation to all stars visible to the naked eye, I made, some years since, an examination of all the stars in Heis' atlas that lie in the Milky Way, and found the number to be 1186 out of a total of 5356, or a percentage of about 22. At my request, Col. Markwick, F.R.A.S., made a similar count for the stars in Dr. Gould's charts of the Southern Hemisphere (Uranometria Argentina), and found that, down to the fourth magnitude, there are 121 stars on the Milky Way out of 228, or a percentage of 53, and for all stars to the seventh magnitude inclusive, there are 3072 on the Milky Way out of a total of 6694, or a percentage of nearly 46. Col. Markwick finds that the Milky Way in the Southern Hemisphere, as shown on Gould's charts, covers about one-third of the whole hemisphere. As will be seen by the above figures, the percentage of stars, even to the fourth magnitude, lying on the Milky Way is considerably greater than this proportion.

"The above results show that the brighter stars which are apparently projected on the Milky Way probably belong to that zone, and are not merely fortuitously scattered over the surface of the heavens."

It will be seen then that exceptional brightness is the characteristic of the stars of all degrees of distance in that part of the sky in which the Milky Way is situated, and it is important to note this in view of the fact that I propose to show that it is a special influence exerted on that particular part of the sky which brings all the stars there into special relief, and the special brightness characteristic of all the Milky Way zone stars will, I presume, justify my using the term Milky Way as applying not only to the luminous stream of the background, but also to the lucid stars of the foreground.

CHAPTER II.

IDEAS ABOUT THE MILKY WAY, AND SUMMARY OF EVIDENCE THAT IT IS A SHADOW EFFECT.

The view of the Milky Way generally taken by astronomers is that it represents a special region or zone of the heavens, and it has even been thought by some that it is a sort of Keel or Central Arch of the Universe, and as our sun appears to occupy a nearly central position in regard to it, this has led to a further deduction being drawn and recently made public, to the effect that the inhabitants of the earth are the unique representatives of mind or intelligence throughout all the starry regions.

This extremely flattering view of our importance is presented in Dr. Wallace's book on "Man's Place in the Universe," and has naturally met with some favor. As my aim is to show that the Milky Way is merely a special shadow effect, it follows, if I am right, that all these transcendent notions as to our sun's proud place in the centre of the starry host, and of man's importance in the scheme of the Universe, are as "the baseless fabric of a vision." It may be well, therefore, to preface my efforts by an apology to my fellow men for the belittling of our rank and dignity which the acceptance of my views would necessarily imply.

The evidence which I propose to submit may be summarised as follows :—

1. The evidence afforded by the position of the Milky Way in its relation to the earth.
2. The anomalies presented in the Milky Way, where we see lucid stars shining specially brightly upon a luminous background of remote telescopic stars, whereas the natural effect of a luminous background is to diminish the brilliancy of lights in front of it. Then again we have this luminous background also specially bright, compared

with other parts of the sky, in opposition to the natural effect, which is, that the brilliancy in front should diminish that of the lights behind. These abnormalities are not explainable, so far as spectroscopic analysis shows, by any special constitution of the Milky Way stars, nor can the unusual brightness of the lucid stars be accounted for as a consequence of special proximity. These peculiarities of the Milky Way are therefore wholly unintelligible except when viewed as a special shadow effect, when the mystery at once disappears.

3. The fact that when the position of stars in the Milky Way is studied relatively to other stars outside it, it becomes evident that there is no special relationship existing between the Milky Way stars themselves. Their special connection with the Milky Way is therefore only apparent, not real, and they do not form any special region, or special system of stars apart from the other stars in the sky.
4. There is some further evidence, the result of observations of the Milky Way, showing that the luminous stream does not always maintain the same relative position to the constellations associated with it when viewed from different parts of the earth.

CHAPTER III.

THE CONSTITUTION AND POSITION OF THE COLUMN OF GREATEST DENSITY OF THE EARTH'S SHADOW.

As the Milky Way does not coincide in its position with the ecliptic centre of the earth's shadow there is at the outset a difficulty to be overcome; as it would naturally be assumed that if the Milky Way were the product of the earth's shadow, the centre of the shadow ought to be represented in the position of the Milky Way.

Though the variation which exists appeared difficult to reconcile, my conviction from the other evidence, that there must be a connection between the two, induced me to persevere until I found the solution I now offer for consideration. The solution appears to me to be both reasonable and correct. It is, that the Milky Way is the product of the greatest density of the shadow, and the centre of greatest density is distinct from the ecliptic or mean centre of the whole shadow. The mean centre of the shadow passes from the earth along the plane of the ecliptic irrespective of what may be the angle of inclination of the earth, and the plane of the ecliptic is therefore the factor which determines the position of the mean centre of the shadow.

The centre of density is however controlled by two factors, viz., the conformation or shape of the earth, and the extent of its inclination to the ecliptic. The conformation of the earth ensures that the greatest density will be at, and near, the equator, and if the earth were upright the centre of density would be the equator; but owing to the earth's inclination to the ecliptic, the centre of density is a mean between these two factors, and passes an equal distance north and south of the equator, and also an equal distance north and south of the ecliptic. A reference to the figure No. 1 herewith will help to explain the matter. The figure is one copied from a work entitled "Smith's Illustrated Astronomy," published at Boston, U.S.A, and designed for use in public schools. It carries a certificate from Mr. S. Newcomb dated 1861, that he has carefully examined it and found it accurate in all its details. The figure is that of the "Terrestrial and Celestial Globes" as given on page 55 of the work, and I have reproduced it as given, but leaving out the stars, and I have added a line marked "P" at each end to represent the central line joining the poles of the Milky Way. This line, so far as it extends on the figure of the earth but not, of course, beyond, will also represent the centre of density of the earth's shadow. It

will be seen that this line passes through the ecliptic and equinoctial at their point of intersection, and that it runs an equal distance north and south of the equator and also of the ecliptic. The extent of the earth's inclination to the ecliptic, as shown by the position of the equator *below the ecliptic* on one side, is seen to be exactly balanced by a corresponding elevation in the centre of density *above the equator* on the other side, so that the centre of density shows its due relation to its two controlling factors, viz., the equatorial centre of the earth, and the extent of the earth's inclination to the ecliptic. In other words the centre of density rises on one side to the same extent that the earth is dipped or depressed on the other. As I have already said, the centre of density, but for this depression or inclination of the earth, would be the equator.

It needs only a little study of the figure to realise how this position of the centre of density is in complete accord with the governing conditions of its origin; and its position would secure its being unaffected by the changes in the general body of the earth's shadow which are the result of the variations in the inclination of the earth to the sun at the different seasons; as the effect of these changes would be confined to the northern and southern ends of the whole shadow. The position of the centre of density would accordingly be permanent.

The figure should also serve as an effective object lesson to show the intimate relationship existing between the earth and the Milky Way, and when considered along with the other evidence, ought, I think to dispel any lingering doubts as to the Milky Way being a local phenomenon.

It scarcely needs any argument to show that the greatest density of the earth's shadow should be at or near the Equator. The shadow is there the farthest removed, on its northern and southern sides, from the influence of the sunlight which is so near to the poles of the earth, and the width of the earth at the Equator aids also in ensuring that greater density of the shadow in the

equatorial regions, which is responsible for the well-known superior brilliancy of tropical skies. The practical absence of twilight in the equatorial regions and its gradual increase as the traveller passes to the north or south, are also indications how the density of the general body of the earth's shadow is affected in proportion to the distance from the equator. This varying density of the shadow is reflected in the appearance of the sky and the stars, which become consequently more or less bright, in our view, according to what are simply our local conditions. It is necessary to emphasise this, as there are some who treat with ridicule the suggestion that such a small local object as the earth's shadow can have any effect on our view of the distant stars. In reply to this I have simply to say that it is this small local object, the earth's shadow, which enables us to see the stars. They are invisible until we are surrounded with this shadow, the shadow of night; and in addition to the common knowledge of the special brilliancy of tropical skies, and the gradually diminishing brightness as we travel north or south from the tropical regions, we are continually being confronted with the effect on our view of the stars of any decrease in the darkness of the shadow immediately around us. There is the moonlight for example. The moon is quite a small local object as compared with even the earth's shadow, and is not so far away from us as the shadow extends into space; yet when the moon rises, the darkness of the shadow around us is decreased proportionately with the degree of moonlight, and there is a corresponding decrease in the brightness of the stars, so that with the moon at the full we can only see the brightest stars. Those who ridicule the possibility of the earth's shadow having any effect in bringing into greater or less relief, according to its degree of darkness, the distant stars, must also, I presume, be prepared to ridicule the idea that moonlight can have any effect on our view of the stars. These critics are of course confusing two quite different things. They treat an effect on our view of the stars as being synonymous with an effect on the stars

themselves, which is of course unreasonable. If we put on coloured spectacles the objects looked at seem coloured. Is this an effect produced on the objects themselves?

In addition to the difficulty of accounting for the variation in the position of the Milky Way from that of the centre of the earth's shadow, there is another difficulty to some in understanding the Milky Way being seen in the position it occupies to the west soon after sunset, or to the east towards sunrise, if it be the effect of the earth's shadow, and therefore opposite the sun. This difficulty, which would easily be resolved by those with some astronomical knowledge, is mainly the result of a failure to discriminate between the apparent position of the sun from a local point of view, and its position in regard to the earth as a whole. The illustration given in figure No 2 will explain this. The figure represents that half of the earth which is not facing the sun, and where it is therefore night. The dotted line across the earth represents the centre of the column of greatest density, the effect of which is to produce the Milky Way. An observer at 0·1 would be in a position where it is just about sunset. The Milky Way is not yet visible to him as the night is not far enough advanced, but to an observer at 0·2 who is, say an hour to the east of 0·1, it is visible as extending round the sky from one horizon to the other. It is also visible to the observer at 0·3, who is within an hour of sunrise, and in his case also it extends to both horizons. By the earth's revolution on its axis, the observer at 0·1 is soon carried to the position of 0·2, and later to that of 0·3, and sees the Milky Way exactly as they did before him, as the earth's revolving on its axis makes no perceptible difference in the position of the shadow, but only in the position of the observer. The observer is carried round with the earth, but the shadow is not. The change in the earth's position, caused by its advance in its orbit, being represented by only four minutes for each day, the resulting alteration in the position of the shadow in the course of any single night would not be appreciable.

This illustration may also help to explain why the Milky Way is apparently a permanent feature in the sky. To some, the idea that a shadow, changing its position with the earth's daily and annual revolution, should produce an apparently permanent effect such as the Milky Way, is incredible, but a little reflection will show how this apparent permanency is secured. Both the annual and the daily revolution of the earth present it in practically the same position relatively to the stars, whose distance is too great to be affected by the comparatively slight change in the earth's position in space caused by its annual journey. The daily advance in its orbit thus brings the earth gradually round the sun without changing the earth's position as regards the stars, any more than does the daily revolution. The shadow is carried on with the earth round the sun, but as I have already said, the position of the column of density preserves it from being affected by any changes in the general body of the shadow caused by the variations in the earth's inclination to the sun at the different seasons. The position of the column of density in relation to the equator and the ecliptic remains therefore unchanged, and is as fixed as are the positions of these lines themselves, and so this continuous unvarying line of density gives the permanent effect which is presented in the Milky Way, which is thus a starry girdle traced around her in the sky by Mother Earth with the help of her handmaid, the Shadow.

In addition to the points just referred to, there is, however, another which has to be borne in mind. It is that the effect of the column of density is not produced on the sky, but is an effect on *our view* of the sky as seen through it. The sunlight is, of course, all round the earth's shadow in every direction, between it and the stars, and as the effect produced by the shadow of night in enabling us to see the stars is merely the result of our local envelopment by the shadow, so in looking at either the sky generally or at the Milky Way portion of it, we must remember that we are still really looking through and

beyond the shadow to where the sun is directly shining. So soon, and so long therefore as we have the shadow around us sufficiently dark we can look in the direction of either sunset or sunrise and see the Milky Way, though the sunlight is between us and it. It may be well perhaps to add that though an observer on a part of the earth which is not within the area of the column of density, is yet able to see the Milky Way, this is owing to the fact that he is looking beyond his immediate surrounding of shadow, and in the direction of, and therefore partly through the column of density. He will, of course, not see the stars generally, nor the Milky Way portion of them, shining so brightly as will the observer who is within the area of greatest density.

On the map in figure 1 the line P.P., extending to the north and south of the celestial sphere, and representing the central line of the Milky Way, is, of course, not an extension of the central line of density, which is confined to the earth, but represents the central line between our views of the northern and southern skies through the column of density.

The column of greatest density which covers a large area at the surface of the earth will, of course, as it extends into space, be gradually reduced by the converging of the general cone of shadow, the narrowing of which will permit of a gradual infiltration of the surrounding sunlight, and consequently a gradual decrease in the width of the column of density, and this is represented in the sky by the gradual decrease in brightness which we see on either side of the Milky Way. The Milky Way itself, represents the most central portion of the column of density.

When we come to consider the evidence afforded by the Milky Way's relation to the ecliptic, I think there is but little further needed to show its connection with the earth's shadow. The centre of the Milky Way, on one side of the heavens, is in Gemini, at the December solstitial point, near the star η, and on the other side it is

in Sagittarius, at the June solstitial point, near the stars λ and μ. At the solstices these points, in their turn, are in the meridian at midnight, and at the equinoxes, at midnight, they are on opposite sides of the heavens, in positions corresponding to an equal distance from the equinoctial points which then represent the meridian.

A line across the ecliptic between these points in Gemini and Sagittarius will divide the Milky Way circle equally. This line, which thus represents the central line of density of the earth's shadow, is, of course, the line of the solstices, and represents the sun's apparent path round the earth. We see, then, that the line of density corresponds exactly with the sun's apparent path, and it follows this path round the earth, with the result that the line of density is reproduced in the heavens in the Milky Way, which extends round one side of the sky from Gemini to Sagittarius, and back round the other side from Sagittarius to Gemini.

The line of the solstices crosses at right angles the line of the equinoxes, which extends across the ecliptic between Virgo and Pisces.

If we extend on the map the line between Virgo and Pisces to the north and to the south, it would divide the Milky Way midway between the points in Gemini and Sagittarius, viz., at a point near α Cassiopeiæ in the north and near α Crucis in the south. These latter points would then represent the north and south poles of the Milky Way, and a circle round the heavens connecting them would have a common centre with the Milky Way circle, this common centre being the point of intersection of the lines across the ecliptic from Gemini to Sagittarius and from Virgo to Pisces. Where is this point of intersection? It is of course the earth. We find then that the earth is exactly in the centre, not really of the Milky Way, but of the phantasmagoric circle in the sky which is called the Milky Way, if such a thing devoid as it is of reality, can have any centre.

CHAPTER IV.

CONSIDERATION OF EVIDENCE.

I will now proceed to consider in detail the further evidence in support of my contention that the Milky Way is a special shadow effect.

First. There are the anomalies of the Milky Way, where we see the front ranks of lucid stars shining specially brightly on a luminous background, and this same luminous background showing up in this part of the sky only, notwithstanding the special brightness of the lucid stars in its front or in its vicinity.

These were the features of the Milky Way which first arrested my attention, and I sought an explanation by studying what is known about the Milky Way. The only reply I could find was in effect that the Milky Way was a special region or zone of the heavens. This, of course, offered no explanation of the special brightness, and the results of spectroscopic analysis of the stars disclose no special constitution of the Milky Way components which might afford an answer.

Professor Newcomb says, in his recent work, "The Stars: A Study of the Universe":—

> "The spectroscope shows that although the constitution of the stars offers an infinite variety of detail, we may say, in a general way, that these bodies are suns. It would, perhaps, be more correct to say that the sun is one of the stars, and does not differ essentially from them in its constitution. This similarity in general constitution does not, however, preclude very great difference in detail. The spectra of the stars shows that hardly any two are exactly alike in the substance of which they are composed, and in the temperature and density of these substances."

And again—

> "The most interesting conclusion drawn from observations with the spectroscope is that the stars are composed in the main of elements similar to those found in our sun."

There is no difference, then, in the constitution of the Milky Way stars from that of the stars as a whole,

except in the case of a small number of stars of a certain class, as to which Professor Newcomb says :—

"Pickering found that the stars of the fifth spectral type, or of Vogel's class IIb, are mostly distributed along the central line of the Milky Way. An exception occurs in the case of a group situated in the 'Magellanic clouds,' a cloud-like mass of small stars too far south to be visible in our latitudes, and detached from the main course of the Milky Way itself. The total number of the stars in question is ninety-one, of which seventy are in the Milky Way and twenty-one in the Magellanic Clouds."

The number of these stars is too insignificant to have any bearing on the question whether the Milky Way stars have any special constitution, and there is no evidence then that, as a whole, they differ in constitution from the stars in general.

Then there is the question : Is the special brightness of the lucid stars in the Milky Way a consequence of their special proximity to us ?

Professor Newcomb gives a list of all the parallaxes of stars which have yet been ascertained, and there are thirty-nine altogether with parallaxes of 0″·10 or over. I take 0″·10 as a limit because the Professor gives a caution that anything under it must be regarded as doubtful. The thirty-nine stars with parallaxes of 0″·10 or over are then the nearest stars to us in the sky so far as has yet been ascertained. They are in the following constellations:—

Cassiopeia	4	
Centauri	1	(α Centauri)
Cygnus	1	(61 Cygni)
Taurus	1	(Aldebaran)
Gemini	1	(Castor)
Auriga	1	(Capella)
Aquila	1	(Altair)
Canis Major	1	(Sirius)
Canis Minor	1	(Procyon)
	12	

Grus ...	...	1	
Draco ...	...	4	
Cetus ...	...	1	
Comae...	...	1	
Ursa Major	...	10	
Indus ...	...	1	
Hydra ...	...	1	
Hercules	...	2	
Eridani	...	2	
Ophiucus	...	1	
Lyra ...	...	1	(Vega)
Piscis ...	...	2	
		27	

The first column represents stars in the Milky Way, and the second column stars outside of it. The stars in Canis Major and Canis Minor are Sirius and Procyon, respectively, which are sometimes shown on maps as on the edge, or a little outside, of the Milky Way. There are, then, only twelve stars in the Milky Way out of the thirty-nine which are nearest to us in the sky, so that special proximity is not a characteristic of the lucid stars of the Milky Way, and their special brightness cannot therefore be explained as a result of their nearness to us.

There is, then, nothing to suggest any reason for regarding the special brightness of the Milky Way stars as being inherent in themselves, or to explain why the lucid stars shine so brightly in spite of their luminous background, while, on the other hand, the background itself is also specially bright compared with other parts of the sky. This is altogether opposed to our experience of the effects of light. A luminous background will diminish the brightness of lights in its front, and, on the other hand, strong lights in the foreground will diminish the brightness of lights behind them. Further, it could not be said that the Milky Way alone contained the remote telescopic stars seen in its background, as they are found also in other parts of the sky, though the Milky Way ap-

parently contains the largest number in proportion to the space it covers. This will, no doubt, be owing to the special density through which it is seen, and which brings the stars into greater relief. There are many millions of stars spread over the sky in all directions, estimates of the total number reaching as high as hundreds of millions, so that the background of our visible sky is everywhere pretty closely packed. (Professor Newcomb, in his summary of conclusions in his work previously mentioned, says. "The total number of the stars is to be counted by hundreds of millions.") But even if the Milky Way really contains a larger proportionate number of remote telescopic stars, it does not lessen, but indeed increases, the difficulty of accounting for the special brightness of the lucid stars in its front ranks, and thus the only reasonable explanation that can be offered is that the influence which is the source of the special brightness of the Milky Way is something outside the stars themselves, and as it serves to bring into special relief both the foreground and background, it must be an influence acting upon the front of both. What could any such influence be? The reply suggested by the appearances, as well as the facts, is a special density of the earth's shadow.

If we study the peculiarities of the Milky Way, such as its varying breadth, its dark channels and spots, and the varying brightness of its different regions, we will find that these are all explainable as the effects which a special density of the shadow would produce, subject to the modifications which would be caused by the variations in the number and brightness of the stars in any particular part of the galaxy, variations such as we find in other parts of the sky.

The varying breadth of the Milky Way stream, for example, is simply the effect produced on the luminous background by the number of lucid stars in the foreground. Where these are most numerous and specially bright the effect is to prevent the fainter light of the background being seen. A glance at any night sky map will show this fairly well. See for instance how the

numerous lucid stars in Argo break up the stream into patches, the vicinity of the bright stars being quite dark. Then again, near the Southern Cross and Centaurus, see how the stream is narrowed and affected by the bright stars there. The well-known Coal Sack is an excellent example of the effect of light on a background In addition to the specially bright stars of α and β Crucis showing on one side of the Coal Sack, there are the bright stars of Musca on the other side, and an ordinary field-glass will show an irregular ring of stars within the Sack and partly around it. The background is accordingly made to appear quite dark, though Mr. Russell, the Sydney Government Astronomer, found that this apparently barren region contained over 6,000 stars! As to the number of lucid stars in this part of the Milky Way, I quote as follows from Mr. J. E. Gore's "Astronomy" (Concise Knowledge Library):—

"The richest spot of all and perhaps the richest in the whole heavens in naked eye stars—with the exception of the Pleiades—is that including the Southern Cross. This spot has an average of three stars to five square degrees, and if the whole heavens were as richly studded with stars there would be about 24,000 visible to the naked eye.* The poverty of the adjoining Coal Sack is very remarkable."

If the natural effect of the specially numerous lucid or "naked eye" stars in extinguishing the light of the lesser luminaries behind or near them is taken into account, the poverty of the Coal Sack background ceases to be remarkable, and the narrowing effect on the Milky Way luminous stream in the vicinity becomes also intelligible If we go north from Argo we find the stream specially broad and well defined to a point beyond Sirius and Procyon, and a glance at the paucity of bright lucid stars in the course of the stream gives the needed explanation. When seen under favorable circumstances, as I have seen it from a height of 3,000 feet in the Blue Mountains near Sydney, the stream is clearly broader than is shown on the map before me (Peck's for 35° south), and its course would bring it well outside

* Professor Newcomb gives 7,647 as the total number of stars to magnitude 6.4. Stars of the sixth magnitude are the faintest visible to the naked eye.

both Procyon and Sirius, but in the immediate neighbourhood of both these stars, their light diminishes the stream. As we go still farther north to Taurus and Auriga we see how the stream is again broken up and narrowed by the influence of the many bright lucid stars there showing. The greatest breadth of the Milky Way is near Scorpio and Sagittarius, and it will be seen how the stream in the neighbourhood of the lucid stars in these constellations is affected by their presence. This will be more clearly seen by looking at the Milky Way itself, than by studying it on a map, because the gradations in the brightness of the stream do not appear on a map. The central position, a sort of turning point, occupied by Scorpio and Sagittarius in regard to the column of density will explain why we see so large an area of the Milky Way showing in their neighbourhood. A similar effect would no doubt be visible in the neighbourhood of Taurus and Gemini but for the presence of the numerous bright stars in their vicinity.

The dark channels and dark spaces of the Milky Way are all in the immediate vicinity of numerous, or specially bright, stars, and of course the natural effect of the lights in front, or in their vicinity, is to extinguish the lesser lights behind, which have only an opportunity of showing up when the bigger luminaries are absent. This is in accord with the conditions in the sky outside the Milky Way, as specially bright stars have dark spaces near them just the same as in the Milky Way, the difference being only that as the Milky Way is subject to the influence of a special density of shadow, the stars in it are made to appear brighter and the dark spaces by contrast darker, than in other parts of the sky. All the anomalies and peculiarities of the Milky Way are thus quite intelligible when studied from the point of view of a special shadow effect.

CHAPTER V.

THE RELATION OF STARS IN THE MILKY WAY TO STARS OUTSIDE IT.

I will now proceed to show that when we study the position of stars in the Milky Way, relatively to other stars outside it, we will find that there is no special mutual relationship between the Milky Way stars; and the bond uniting them is only apparent, not real. They do not therefore occupy any special region in the sky or form any special system of stars.

If it be asked what is meant by a special region of the sky, or a special system of stars, so far as these terms are applicable to the Milky Way, there is a difficulty in arriving at what is the general recognition by astronomers of the meaning implied, as most of the references to the Milky Way in astronomical works are necessarily speculative owing to the failure to recognise its true character, but I find in one instance at any rate an attempt at a definition. It is in a quotation on page 31 of the Knowledge Diary for 1904 as follows:—

"THE WONDERS OF THE MILKY WAY.

"If it is proved that a group of stars is arranged in line or marshalled in any order, it would follow that the individuals of the group must be actually as well as apparently close to one another, and that they form some kind of system, having all of them had a common origin, or been subject to some common influence. What these streams and curves of stars mean, and what forces have marshalled them in lines, forms one of the grandest problems of the future, one that I trust I may live to see unravelled."—A. C. RANYARD in *Knowledge*.

The quotation is, I presume, from an article or paper by Mr. Ranyard which I have not seen, but I am glad Mr. Ranyard took the trouble to formulate his ideas as to the conditions which should be found to exist in the case of stars marshalled in any order or grouped together, if such marshalling or grouping is a reality and not merely an appearance. I presume his definition may be accepted as a reasonable one, and I therefore propose to put his conditions to the test.

The first condition to take in hand is that referred to in the statement that "it would follow that the individuals of the group must be actually as well as apparently close to one another."

Now it would be a comparatively simple task if I had only to show that the individual stars of the Milky Way groups are not actually as well as apparently close to one another, but I have to go further and to show that not only does this mutual special proximity not exist among the Milky Way stars, but that on the contrary stars are grouped together in the Milky Way, in apparent proximity, which are not only extremely remote from each other, but some of them are, on the other hand, near neighbours of stars which are altogether outside the Milky Way. To give a few instances to begin with take the nearest stars to us in the heavens—α Centauri, Llalande 21185, 61 Cygni, and Sirius, distant respectively $4\frac{1}{3}$, 7, $8\frac{1}{3}$, and 9 light years. Where are these stars situated? Three—α Centauri, 61 Cygni, and Sirius are in the Milky Way, while Llalande is in Ursa Major, and far outside the Milky Way. α Centauri is in the southern circumpolar stars on the opposite side of the heavens to Llalande and 61 Cygni, which are in the northern circumpolar stars, while Sirius is in that part of the sky which is nearly opposite the equator. These four stars are our nearest neighbours, and must be also on that account not far distant, on the stellar scale, from each other. A circle, with our Sun in its centre, and having a radius of nine light years, would include them all, whereas apparently alongside α Centauri in the Milky Way is β Centauri, which is given a parallax in Professor Newcomb's list of $0''{\cdot}05$, which would represent a distance from us of sixty-five light years, and about the same distance from α Centauri. Is then α Centauri nearer to β Centauri than it is to Llalande 21185 in Ursa Major on the other side of the heavens and outside the Milky Way? It may be replied it is in the same region of the sky as β Centauri, because it appears to be in the same direction. Then again, there

are 61 Cygni and α Cygni, both apparently close to each other in the Milky Way, but while 61 Cygni is only eight light years from us, no parallax has been ascertained for α Cygni, which is therefore still more distant than β Centauri, and may be even hundreds of light years away. α Cygni is then much farther from its apparent near neighbour, 61 Cygni, than the latter is from Llalande 21185, or from α Centauri, which is on the opposite side of the heavens. The same reply may of course be made in this case as in that of α and β Centauri, that is, that though 61 Cygni and α Cygni may be very far apart from each other, they are in the same region of the heavens. This is the objection I have to meet, and it is not, therefore, sufficient to disprove Mr. Ranyard's condition that the individuals of any apparent group must be actually as well as apparently close to each other. I have to show that the direction in which stars appear to be depends entirely on the point of view, that the apparent proximity of stars may be entirely fallacious, because the nearer we are to any stars the more distant they seem to be from each other—or, to put it more correctly, the nearer any stars are to us, so the space between them appears greater than does an equal extent of space between more distant stars. Instances of this are seen in the case of the four stars just quoted which, though really near to each other from the stellar point of view, are separated by large spaces of the sky. Llalande 21185 and α Centauri are on opposite sides of the heavens from each other, but are only nine light years apart, while between them are thousands of stars whose distance from either α Centauri or Llalande enormously exceeds the distance of these two stars from each other.*

When I have made all this clear it will then become evident that, to quote Mr. Ranyard again, "if we find a group of stars is arranged in line, or marshalled in any order," instead of this suggesting, as he says, "that they are really as well as apparently close to one another and

* I am indebted to Mr. C. J. Merfield, F.R.A.S., for the calculations of the distances between α Centauri and Llalande 21185 (9 light years), and between Sirius and Procyon (5·3 light years).

form some kind of system with a common origin," it should, on the contrary, arouse suspicion and suggest that "some common influence" is certainly at work, but an influence of an entirely delusive character, an influence which affects the objects influenced in a way to disguise the truth about them, and which, in this case of the Milky Way, literally places them in a false light. This must be the true character of any influence which links or groups together in arbitrary fashion in any circle, semi-circle, or other continuous form, stars of enormously varying distances from each other, and therefore belonging to entirely different regions in space, while excluding other stars which are among the nearest neighbours of some included in the group.

In order to arrive at an idea of the relative position we occupy in regard to some of the stars, and also to try to realise what is the relative position of these stars to each other, I must give some examples of what we know from our terrestrial experience of the effect of distance on our view of objects, as the lessons this experience teaches are applicable also to the stars. The examples may appear rudimentary to those with even a slight knowledge of astronomy, but I am indifferent to this, as the lessons they teach seem to have been somehow overlooked in their application to the Milky Way.

Let us suppose an extensive plain, in the middle of which is a village or town, with four roads, running north, south, east, and west, and meeting in a common in the centre of the town, also that there are houses at intervals of a quarter of a mile from each other on each side of the four roads, and extending two miles from the central common. Figure 3 will show the roads and houses as they really are. The houses are represented by small circles. Figure 4 represents the appearance of the roads and houses as an observer would see them from a central position on the common. It will be seen that each road narrows to a point in the distance, and that the houses become smaller and are drawn closer together the farther they are from the observer.

Now the observer is to mount in a balloon directly above his central position. As he rises he will see the plain becoming smaller and smaller beneath him, and the roads becoming shorter and the houses smaller, while all are being drawn together to the central point immediately below him. If he should ascend far enough he would find the town reduced to a little spot, and all the houses will be close together in the centre as little specks. As he descends the objects will of course open out as he approaches them, until he and they return to the first position. Now if instead of rising the observer should travel from his central point along any of the roads either to the north, south, east or west, he would find as he advanced that the road and objects in front of him would open out till he had passed beyond them, and then that a similar concentration of the roads and houses to what he had seen from the balloon would take place, except that it was occurring behind him instead of beneath him, with the result that when he had travelled a certain distance, if he were going to the north the roads and houses would be eventually concentrated in a small spot on the line behind him, that is south of him. If he travelled to the east, the concentration would take place also behind him, that is to the west. The objects then, which, as seen from his central position on the plain, were respectively to the north, south, east or west, would alter their bearing according to the direction in which he travelled, and they would therefore be all to his north, south, east or west, according to the new point of view from which he saw them. Now this is what I desire to impress upon my readers' minds, in order to enable us to discover whether stars which appear to be in the same direction in the sky are really so, and it will enable us to realise how the seeming relative position of stars will depend entirely on the point from which they are viewed.

There is another example which it is desirable to have as showing the effect of distance on our view of stars.

Figure 5 is supposed to represent five ranks of five stars each. The stars in each rank are ten light years

apart from each other, and each rank is ten light years behind that in front of it. The figure represents the stars in their positions as they really are. Figure 6 will show how they would seem to be placed when looked at from the earth. It will be seen that each rank occupies a smaller space in the sky than the one in front of it, and the apparent distance between each star becomes less and less the farther the stars are away from us. It will be evident that if we continued to add further ranks of still more distant stars we would eventually reach a point when the five stars covering a space of some forty light years between them would be represented by a small spot in the distant sky, and we realise, first, that what is a large space in the foreground of our sky is represented in the far distance by a mere point, and conversely that a very small space in the remoter regions, say of the telescopic stars of the Milky Way, will represent a very large one in the lucid star portion of our sky.

I will now proceed to turn these examples to account by showing how they affect our view of the Milky Way.

I will deal first with four of the nearest stars, viz., α Centauri, Llalande 21185, Sirius, and Procyon, distant respectively $4\frac{1}{3}$, 7, 9, and 11 light years. In figure 7, they are placed as I find them in a recent number of "Knowledge" (March, 1905), in a paper by Mr. T. E. Heath, on "A New View of the Stars."

Now if we imagine ourselves receding from between Sirius and Procyon in the direction of the equinoctial line—that is, if we treat Sirius and Procyon as to our east, we are to travel west—we will, remembering our terrestrial experience, find on looking back that all four stars are drawing closer to the line on which we are travelling, while at the same time drawing closer to each other, till, when we had gone far enough, we would find all four in a group behind us in the order of their relative distances from us, that is, α Centauri would be nearest to us, Llalande next, then Sirius, and lastly Procyon. The concentration will have taken place on the line behind us, that is, on an extension of the equinoctial, and as

α Centauri is well in the middle of the Milky Way stream and Sirius and Procyon are on opposite sides of it, Llalande, which would have α Centauri on one side and Sirius and Procyon on the other, would surely not be able to escape from it seeing that beyond α Centauri the stream extends still further even than β Centauri, which is some sixty light years beyond α Centauri while Llalande is only about three. We see then that by simply changing our point of view, a star, Llalande 21185, which as seen from the earth is well outside the Milky Way, has been transferred to a central position among stars in the galaxy. This transformation scene is not a mere bit of legerdemain. It will stand the test of critical examination, and must then force the conviction upon anyone studying the matter, that the deception is not in my representation, but is really attributable to the specious appearances of the Milky Way.

An interesting question suggests itself here, viz.: How did Llalande 21185 manage to get into its new position among the Milky Way stars, seeing that it is apparently outside the Milky Way circle altogether? To our south the Milky Way circle includes α Centauri, only $4\frac{1}{3}$ years from us, and takes in β Centauri, which is at least sixty light years beyond α Centauri. As we go north we find the circle has Sirius on one side and Procyon on the other, distant respectively nine and eleven years. Yet Llalande has managed to get in between α Centauri and Sirius. To do this, Llalande must have somehow managed to cross the circle—but where?

I have shown in this instance how a star which is outside the Milky Way may be introduced within the magic circle. I will now give an illustration of how further stars may likewise be brought within the precincts, while others which are already there may be ejected.

I shall deal again with that portion of the Milky Way near Sirius and Procyon, as the equinoctial line is handy as a point of reference, as well as for travelling upon. There are three stars here, viz., Sirius, Procyon, and Betelgeux, which form together a triangle in the sky.

Sirius is about nine light years away from us, and Procyon about eleven light years. In Professor Newcomb's list, Betelgeux is given a parallax of 0″·02, but he gives a caution that any parallax under 0″·10 is to be regarded as doubtful. If we take it as 0″·02, it represents a distance of 162 light years. As the parallax is doubtful it may of course be further away, but we may presume that the star is at least 162 light years away. All three stars are near the edge of the Milky Way according to the Maps. Now I propose to make a journey on a line between these three stars, towards that portion of the Milky Way stream which would be traversed by an extension of the equinoctial, and which is somewhere near the middle of the triangle formed by the three stars, and also in the middle of the stream. A journey of ten light years will then bring us about midway between Sirius and Procyon, which are separated from each other by a distance of 5·3 light years While travelling towards the central point I have indicated, we would find, of course, as our terrestrial examples indicated, that Sirius and Procyon will be seen separating, opening out on either side of us till, when we reached the central point, we were steering for, ten light years away, they would be seen far away on each side of us, and in quite different parts of the sky. We can readily realise this when we remember that Llalande 21185 and α Centauri, distant respectively 7 and $4\frac{1}{3}$ light years from us, are only nine light years from each other, and are yet on opposite sides of the heavens.

Figure 7 will show the apparent positions and relative distances from us of α Centauri, Llalande, 61 Cygni, Sirius, and Procyon, and we have to bear in mind the fact that the nearer stars are to us the farther away they appear to be from each other. When we had reached the ten-mile stage between Sirius and Procyon these two stars would have travelled away from each other on their respective circles, Procyon in a direction bringing it towards Llalande, and Sirius in a direction towards α Centauri. The two stars, Llalande and α Centauri,

would, on the other hand, have approached each other somewhat, because our new point of view, ten years away, would have removed us to a little greater distance from them, and they would therefore seem closer together. Now, as the luminous stream of the Milky Way is composed of telescopic stars at a vast distance from us, our journey of ten light years in its direction would make little or no difference in its apparent width, and, consequently, as Sirius and Procyon had receded as we approached them and had been driven away to opposite regions of the sky, our shifting our point of view in this case would have had the result of ejecting Sirius and Procyon from even the neighbourhood of the Milky Way.

As regards Betelgeux, as it is so distant it would have but slightly altered its position compared with what it was as seen from the earth.

Now, if we continued our journey on the same line, that is, towards a point far away in the middle of the luminous stream, our next experience with regard to Sirius and Procyon would be to find them returning to their first positions in proportion as we advanced on our journey, as we would now be receding from them, the effect of which, of course, would be to bring them closer together. But as well as Procyon and Sirius, the other stars, Llalande and α Centauri, would also be seen further converging in our wake, until before we had gone very far, the four stars would be found very close together in a line behind us. And not only these four stars, but also 61 Cygni, only $8\frac{1}{3}$ years distant from our sun, would be seen accompanying them. Still journeying on in the same direction one after another of the nearest stars to our sun would be seen joining the cortege in our rear, till by degrees the whole of the thirty-nine stars previously specified, whose parallaxes are $0''{\cdot}10$ or more, would have been sifted out of the crowd of stars in the sky, and eventually would be seen in a group close together behind us. Where would this be? It would be in the middle of the Milky Way in a small space in the middle

of the triangle formed by Procyon, Sirius, and Betelgeux. Can there be any doubt of this, or that an observer at, say, Betelgeux's distance will see the thirty-nine stars which are our nearest neighbours all grouped together in the small space they occupy in the sky, a space included in a circle which has only a radius of thirty-two light years? But if we are not far enough at Betelgeux's distance to bring about this result, we have only to continue our journey in the same direction to surely bring it about eventually. What is the extent of space in a circle with a radius of thirty-two light years compared with the space represented by the thousands of telescopic stars in even a section of the luminous stream between Sirius and Procyon? The Coal Sack contains over 6,000 stars. Take a section between Procyon and Sirius equal in area to the Coal Sack, and we will doubtless have the same number of stars in it. What area would 6,000 stars cover if spread out in the sky as near to us as are the lucid stars? We can form an idea from what we know of our sky. We have no reason to think that the stars anywhere in space differ very greatly, on the whole, from those in our neighbourhood, and our sky contains altogether but a total of 7,647 stars visible to the naked eye, including those only faintly visible. Is it a reasonable conclusion then that any small section of the Milky Way slightly larger than the Coal Sack will contain over 7,000 stars, occupying an area equal to that occupied by all the stars we can see with our unaided vision? If so, is it not clear that even a small spot only of the Milky Way stream would extend over and include, not only the twelve lucid stars among our near neighbours which we see in the Milky Way, but also the other twenty-seven stars which are their and our near neighbours, and which are outside of the Milky Way, and it would certainly be seen to do so when observed from any distance which would be far enough to group our sun and his thirty-nine near neighbours together. At the distance of the telescopic stars of the Milky Way, the space represented by a circle with a radius of thirty-two

light years, would be insignificant. At the distance of our nearest star, α Centauri, a space of $4\frac{1}{3}$ light years is represented by a mere hairsbreadth, and the stars in the stream of the Milky Way must be hundreds of times farther from us than is α Centauri. The parallax of α Centauri is three-quarters of a second, and we are told that one second represents the angle subtended by a half-penny (which is one inch in diameter) at a distance of 3·26 miles.

The experience gained by our voyage between Sirius and Procyon would also be that of an observer in quite a different direction. For example, α Cygni has no ascertained parallax, but is well in the middle of the Milky Way stream, with 61 Cygni apparently close to it, but while 61 Cygni is only $8\frac{1}{3}$ light years from us, α Cygni may be hundreds of years away. If we then make a journey on a line between 61 Cygni and α Cygni we would meet with the same experience as on the journey between Sirius and Procyon, as the sun and his thirty-nine near neighbours would then be seen by an observer at α Cygni all grouped together near 61 Cygni, and therefore in the middle of the stream. Or we could make the same journey and meet with a similar experience on a line taking us between α Centauri and β Centauri towards β Crucis, which is a star without an ascertained parallax, and therefore is probably hundreds of light years away. These results should, of course, be obvious when it is considered what an enormous space is covered by even a very small section of the remote luminous stream of the Milky Way, and should show how crude is the notion that there is any special relation between the luminous stream and the few lucid stars which happen to be in its foreground. What is but a small section of the luminous stream anywhere, may even represent space sufficient to cover not only the stars apparently under it, but the whole of the 7,000 odd lucid stars visible in our sky.

What opinion then can be formed of the Milky Way as a special region of the sky, or as a special system of

stars when, as we see from the instances given we can exclude from its privileged precincts some of the stars already within them, and introduce outsiders in their place, by the mere process of changing our own point of observation ?

I have said nothing as to the effect on the luminous stream above us as we approached it on our imaginary journeys, but it is obvious that as we ascended, the stars above us would spread out, while the stars below were drawing together, till if we went high enough, we would find the position entirely reversed, that is all the stars which were around us on the earth would be transposed into a group of remote telescopic stars in a small space beneath us, and the telescopic stars above would have become the lucid stars surrounding us on every side.

To indicate in another fashion how devoid of any reality is the apparent association of stars in the sky, whether in a circle or only as a constellation figure, look at the constellation of Cygnus the Swan, which is in the Milky Way. The only star in it with an ascertained parallax is 61 Cygni, which is a double star. The remainder of the stars in the constellation may therefore be hundreds of light years away, and as they extend in various directions they must be in regions quite remote from 61 Cygni. Some distance apparently away from Cygni is the constellation of the Great Bear, Ursa Major, which is far outside the Milky Way. In Ursa Major there are no less than ten stars with ascertained parallaxes of more than 0″·10, and these ten stars must consequently be all much nearer to 61 Cygni than any of the stars in its own constellation. 61 Cygni really therefore, if proximity means anything, is more closely allied to the Great Bear family than to the Swans. This fact, viz , that the two 61 Cygnis are really more Bears than Swans, suggests the silly remark, which I apologise for mentioning, that it may perhaps be the reason why all the real Swans have removed themselves to such a safe distance.

Then again we have the apparently near neighbours α and β Centauri and α and β Crucis. α Centauri is 4½ light years from us, and β Centauri has a parallax assigned to it of 0″·05, which if correct gives it a distance of 65 years. α and β Crucis have no ascertained parallaxes. α Centauri is then much nearer to Llalande 21185 and 61 Cygni, which are in the northern circumpolar stars, than it is to its apparent next-door neighbour β Centauri; and as we can now realise from the experience we have gained on our excursions among the stars, if we were to travel on a line between α and β Centauri we would find them separating from each other until they no longer appeared to be in the same region. It seems absurd to say so, but it is nevertheless a fact, that if the parallaxes assigned the north star, Polaris, 0″·06, and β Centauri 0″·05, are correct, α Centauri is nearer to Polaris than to β Centauri. A parallax of 0″·06 represents 54 light years from us. Add our distance from α Centauri 4½ years and we have 58 years between α Centauri and Polaris, whereas β Centauri's parallax represents 65 light years from us, and the distance from α Centauri would be much about the same. As α and β Crucis have no ascertained parallaxes* they are certainly much farther away from their apparent near neighbour α Centauri than the latter is from Polaris, and even β Centauri would also be nearer Polaris than to the Southern Cross stars. The question of direction of the stars from each other as we have seen depends entirely on the point of view. Our view from the earth can give us no correct idea of the relative position of the stars to each other—even of those which are the nearest to us. It merely shows how they appear to us, and a comparatively small change in our position alters the view completely. We can then form not the faintest idea of what is our relation to stars further away, even to those which, on the stellar scale, are comparatively near, as all grades of stars from the

* For my quotations of parallaxes, I rely on Professor Newcomb's list in his recent work, "The Stars: a Study of the Universe."

nearest to the very distant are intermingled together so that some of the nearest are apparently alongside some which are very remote.

It ought to be evident then that any grouping of stars together must necessarily include stars of greatly varying distances from each other, while excluding others which are really near neighbours of some included in the group, and the grouping therefore is entirely accidental and devoid of reality. It would in fact be as reasonable to regard any circles, squares or triangles so formed as real, as it would be to regard the constellations called after birds, beasts and fishes as real representatives of these animals.

CHAPTER VI.

CONSTITUENT CONSTELLATIONS OF MILKY WAY CIRCLE.

Before considering the evidence afforded by the the discrepancies found to exist in different maps in the position of stars in regard to the luminous stream, it may be well to submit the Milky Way circle to a process of dissection in order to discover what are its constituents. This dissection will necessarily be limited to the constitution of the lucid star portion of the Milky Way, and it may therefore be objected that this is only its skeleton, but we are unable, in consequence of its remoteness, to do anything with the luminous stream in the way of identifying any particular part of it, seeing that it is always the same indistinguishable mass of closely congregated stars.

If we look at a map of the night skies we will find that there is one occasion when the whole of the constellations, seventeen in number, associated with the Milky Way, may be seen showing in the sky. This is at the March equinox, while at the September equinox, sixteen out of the seventeen are present. Figures 8, 9, 10 and 11 show the constellations visible at midnight at the times of the equinoxes

and solstices, and I have given a number to each constellation to facilitate comparison of the positions occupied by the constellations at different times, and also to aid in identifying which are present and which are absent on each occasion. I include in this list of constellations all those through which, or portion of which, the luminous stream passes, and I have included Canis Major and Canis Minor, although their stars, Sirius and Procyon, are shown in the maps as just outside the edge of the stream.

The peculiarity of so much of the Milky Way circle being always visible is explained by the fact that a large part of it is made up of circumpolar stars, which are visible in the sky every night. It is always the same circumpolar constellations which come into the course of the shadow, and are thus brought into line with the equatorial or ecliptic constellations in order to form the circle. The constellations associated with the Milky Way are as follows:—

1. Cygnus
2. Cepheus
3. Cassiopeia
4. Perseus
5. Auriga
6. Taurus
7. Gemini
8. Orion
9. Canis Major
10. Canis Minor
11. Argo
12. Crux
13. Centaurus
14. Ara
15. Scorpio
16. Sagittarius
17. Aquila

At the March equinox at midnight we have present at one time in the sky, part in the northern hemisphere and part in the southern, the whole seventeen of the constellations, though No. 8 (Orion) and No. 17 (Aquila) are nearly altogether below the horizon, and most of the northern hemisphere constellations are low down (fig. 8). At the September equinox at midnight, we have present sixteen of the constellations, the only one unrepresented being No. 10 (Canis Minor), and most of the Southern hemisphere constellations are low down on the horizon (fig. 9). At the June solstice at midnight there are present in both hemispheres Nos. 1-5 and 11-17, those

absent being 6-10, viz., Taurus, Gemini, Orion, Canis Major and Canis Minor, and the Milky Way is seen stretching from a little east of north to a little west of south in a semi-circle (fig. 10). At the December solstice there are present Nos. 1-14, the absentees being 15 (Scorpio), 16 (Sagittarius), and 17 (Aquila), and on this occasion the Milky Way is also seen as a semi-circle, but extending from a little west of north to a little east of south.

It will be observed that it is always the middle section of the Milky Way which is absent at the solstices, the northern and southern sections being constantly in attendance on all occasions, and that at the December solstice, when we have what resembles a full semi-circle in view, the remaining unseen portion of the whole circle of the Milky Way is made up of three constellations only, viz., Scorpio, Sagittarius and Aquila.

At the June solstice the absentees are five, Taurus, Gemini, Orion, Canis Minor and Canis Major.

The two semi-circles then which we see at the times of the solstices are both composed of the same constellations at the northern and southern ends, and the only changes are in the middle sections. The connections between the different sections are effected so skilfully that we have always presented to us a circular or semi-circular line or band round the sky. If we look at a map or a globe—and the larger the scale the better—and note the relative positions of the constellations of the Milky Way, they do not seem to offer a promising aspect as ingredients in the formation of anything approaching a circle, but the connecting medium is not in operation in the case of a map or of a globe at rest. It requires the revolutionary motion of the earth to bring the constellations under the influence of the connecting link, the centre of density, and the alliance once established, is maintained and repeated day after day, or rather night after night, until it becomes the harmonious and enduring one we see presented in the Milky Way. The fact that we have all the constellations of the Milky Way in view

at one time, at the March equinox, with but a trifling difference at the September equinox, is not without its significance in considering whether the Milky Way can be an effect of the earth's shadow, as at these times, when we have the most complete view we can get of the Milky Way circle, we have the evidence of our eyes that the whole, or nearly the whole, of its extent is confined to that part of the sky which we can see through the shadow at one time.

At the solstices again we see that by far the greater portion of the Milky Way is also visible at one time in the sky, the constellations which are absent representing only a small area of the whole.

I may here put this question: If the Milky Way constellations represented any real continuous circle in the sky such as they seem to do (*vide* figure No. 1), would not the effect of the earth's revolution present them to us as describing a series of separate parallel circles round the sky; each constellation following its vis-a-vis in the galactic ring round the heavens in a circle confined to the two of them, and each separate circle always maintaining the same relative position to the other separate circles of the whole galactic ring? Instead of this we have the Milky Way constellations travelling round the sky in circles at various angles to each other, such as those of the northern and southern circumpolar stars, the north and south ecliptic and the equator.

CHAPTER VII.

DISCREPANCIES SHOWN IN MAPS.

With regard to the discrepancies shown in maps as to the position of the luminous stream in regard to stars in or near it, a comparison of different maps, particularly of maps recording observations made at widely different places, will show that there appears to be a great difference of opinion on the subject among mapmakers, and it

must be borne in mind that what appears only a small difference on a map represents a large space in the sky. On this point of difference in maps of the Milky Way, I may quote here the remarks of Mr. E. W. Maunder, F.R.A.S., at a meeting of the British Astronomical Association in London, on 27th January, 1904, in reference to a paper by Mr. F. H. C. Gregg, on "The Study of the Milky Way."

"Mr. Maunder said he certainly thought it would be a very good thing if such a Section as that suggested by Mr. Gregg could be started. Of course, it would be absolutely hopeless for anyone in London or in any big town to join such a Section. The only members who could do any good work in that direction would be country members living far away from the lights of the towns. But the work was a very important one. It certainly was not to the credit of astronomers generally that, up to the present day, one of the very best descriptions of the Milky Way that they had was that which they owed to the old astronomer, Ptolemy. There was a further aspect of the work, which he thought could only be brought out by a Section, that was to say, by several observers working in concert and the work being discussed by some one competent leader. The charts which Dr. Boeddicker, Mr. Backhouse, Mr. Easton, and others to whom Mr. Gregg referred, had made of the Milky Way, showed, as one would expect, that there was a considerable amount of personality in the actual method of observing and of interpreting what was seen, and it seemed to him that they could get over that difficulty only by actually bringing together a large number of studies by independent workers on the same object, and then seeing in what characteristics the personality of each consisted, and so be able to eliminate it. A great deal had already been done in that direction in planetary drawings, and probably more still could be done, and in this field which had been so little attempted, such work would necessarily be most valuable."

It will be seen that the existence of the discrepancies in different maps is well known and, therefore, I need not perhaps go into this part of the evidence at any length. I know from my own experience that it is difficult at times to say positively what are really the boundary lines of the luminous stream anywhere in the sky. This is especially the case near the horizon, and again on some nights the stream shows itself much more clearly than it does ordinarily. I may, however, mention two instances which seem to present examples of marked deviation.

First, in the northern hemisphere there is the position assigned to Capella, in "Smith's Illustrated Astronomy," the Boston publication already referred to, as compared with its position as given in the English maps in "Proctor's Star Primer." I take this case as Capella is a very prominent star, and its position, therefore, it might be expected, would be set down as accurately as possible. In Proctor's maps, Capella is shown as in the stream of the Milky Way though on its edge, and Capella's neighbours, ϵ and η Auriga, are shown as being further in the stream, but in the Boston map, not only is Capella shown distinctly clear of the stream, but so is the neighbouring star ϵ also. As I have already remarked, a small difference on a map represents a large space in the sky. In this particular case the effect is that, while in the English maps for July, August, and September, the Milky Way is shown accompanying Auriga round the northern horizon after Gemini has disappeared, the Milky Way disappears from the American map after Gemini has gone out of sight, though Capella and its neighbouring stars continue visible. The stream does not appear again in the American map until just before Gemini comes into view in September.

In the southern hemisphere I have, for several months past, between January and May of this year, observed carefully at different opportunities, the position of Scorpio, and could not reconcile it with the position given in Peck's map for 35° south, in which practically the whole of Scorpio is shown as included in the stream, only the star β being left out, and δ and π are shown as on the edge, as also are Antares and his two neighbours σ and τ (see fig. 12). Now on every occasion I have found that the head of Scorpio and also Antares and his neighbours σ and τ were clearly outside the stream, the northerly edge of which passed south or south-east of Antares' southern neighbour τ. There was no possible doubt of this. I have had the observation confirmed over and over again by younger eyes than my own, though mine are pretty good still. In this case the space from

Antares' southern neighbour τ to the head of Scorpio is considerable, and I cannot imagine how the great variation shown in the map can be accounted for as a simple error of observation. The question suggests itself: Where was the observation made which is recorded in the map? The map is published in London, but Scorpio is not well seen in the sky so far north as London.

That the changes which doubtless occur in the position of the luminous stream with regard to the constellations associated with it, as viewed from different parts of the earth, have not received special attention or awakened suspicion as to the permanency of the position of the Milky Way, is to some extent explainable by the fact that the Milky Way is not everywhere seen frequently to the best advantage, a dark, clear night being indispensable, and even in regions where the sky is usually clear, moonlight has its extinguishing effect. Then, owing to the nature of its origin, the edges of the stream are not everywhere clearly defined, and when low down in the sky it is very easily confused with the light which will usually be found round the horizon. Then again, any comparisons made of observations taken from positions not far apart would not reveal any great deviations. Of course, as the shadow does not, from the astronomical standpoint, extend very far away from the earth, the centre of the column of density will be seen at different angles by observers who are widely separated from each other, the centre, which is represented in the luminous stream, being projected further away in proportion to the distance of the observer's position from the centre.

No doubt, if careful observations are made of the position of the luminous stream and compared with similar observations made from widely distant points, there will soon be forthcoming ample evidence to show the really fortuitous character of the association of the components of the Milky Way circle; and that instead of being the special region of the heavens it has hitherto been held to be, or the Central

Arch of a Universe in which we are the sole representatives of mind or intelligence; it will be plain that in the Milky Way circle we have presented to us what is nothing more or less than an interesting celestial example of a fortuitous concourse of atoms—the atoms being rather large.

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Fig. 1.

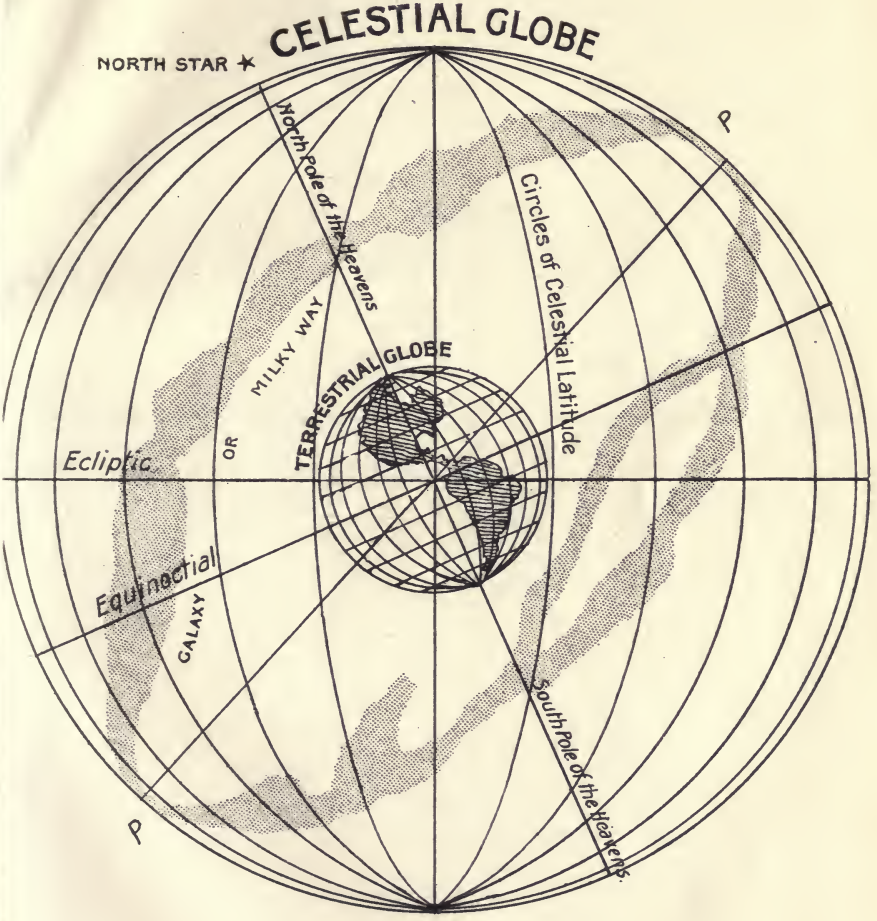
CELESTIAL GLOBE
NORTH STAR ★
North Pole of the Heavens
P
Circles of Celestial Latitude
MILKY WAY
OR
GALAXY
TERRESTRIAL GLOBE
Ecliptic
Equinoctial
P
South Pole of the Heavens

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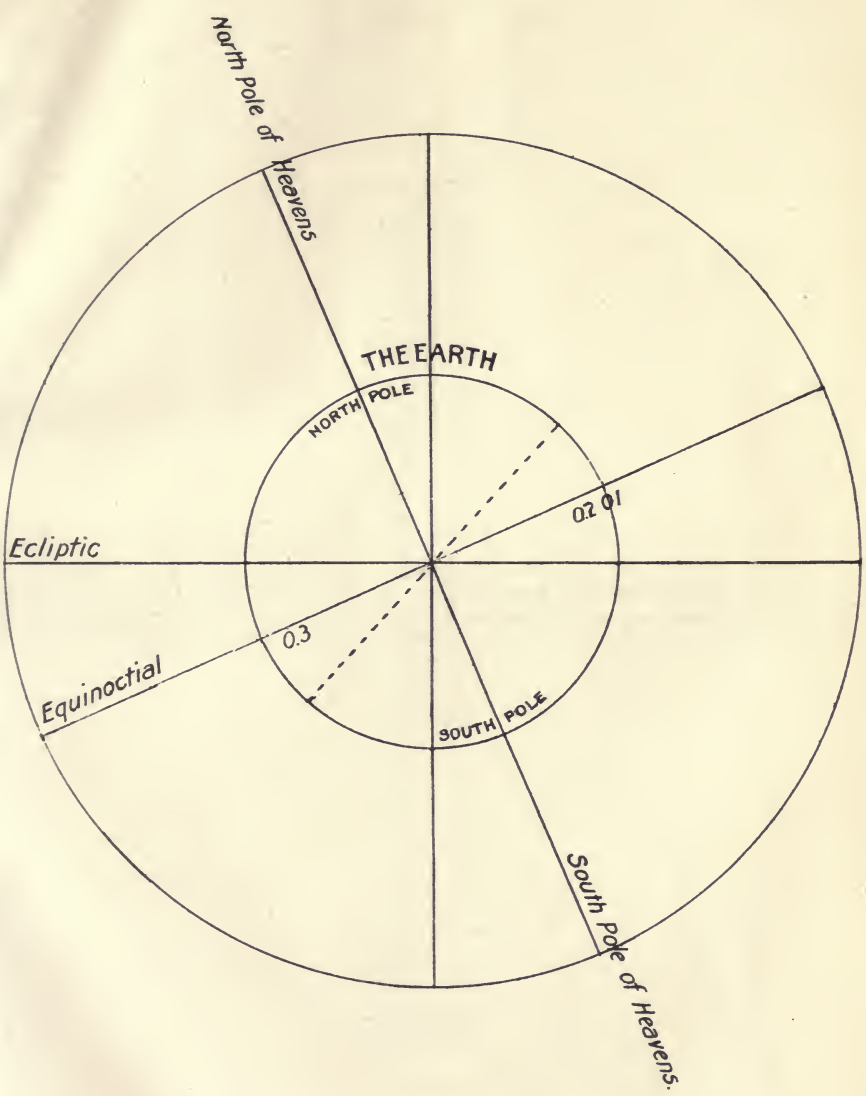
Fig. 2



01 is the position of an observer at sunset.

02 is the position of an observer at an hour after sunset.

03 is the position of an observer at an hour before sunrise.

In this figure the West, in accordance with the usual practice in astronomical maps, is placed on the *right* side, which would be the wrong side in terrestrial maps.

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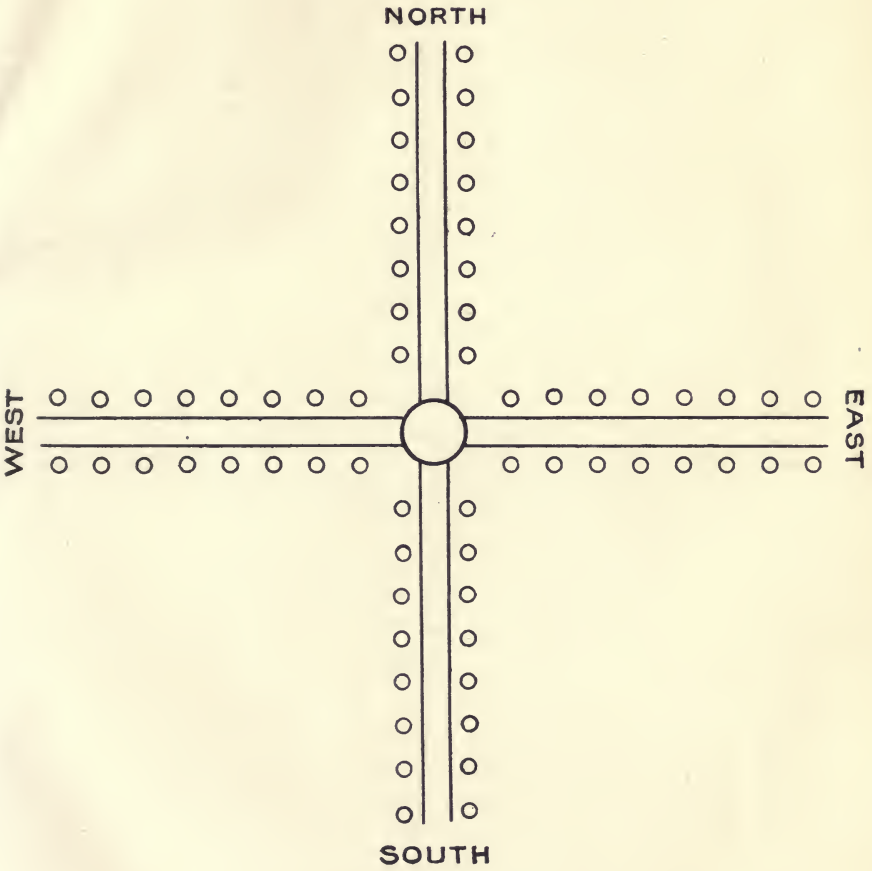
Fig. 3



In Figures 3, 4, 5 and 6 the aim of the artist is not mathematical exactness, and is rather suggestive than realistic, to, in fact, stimulate the imagination to endeavour to realise what is the object intended by the picture.

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Fig 4

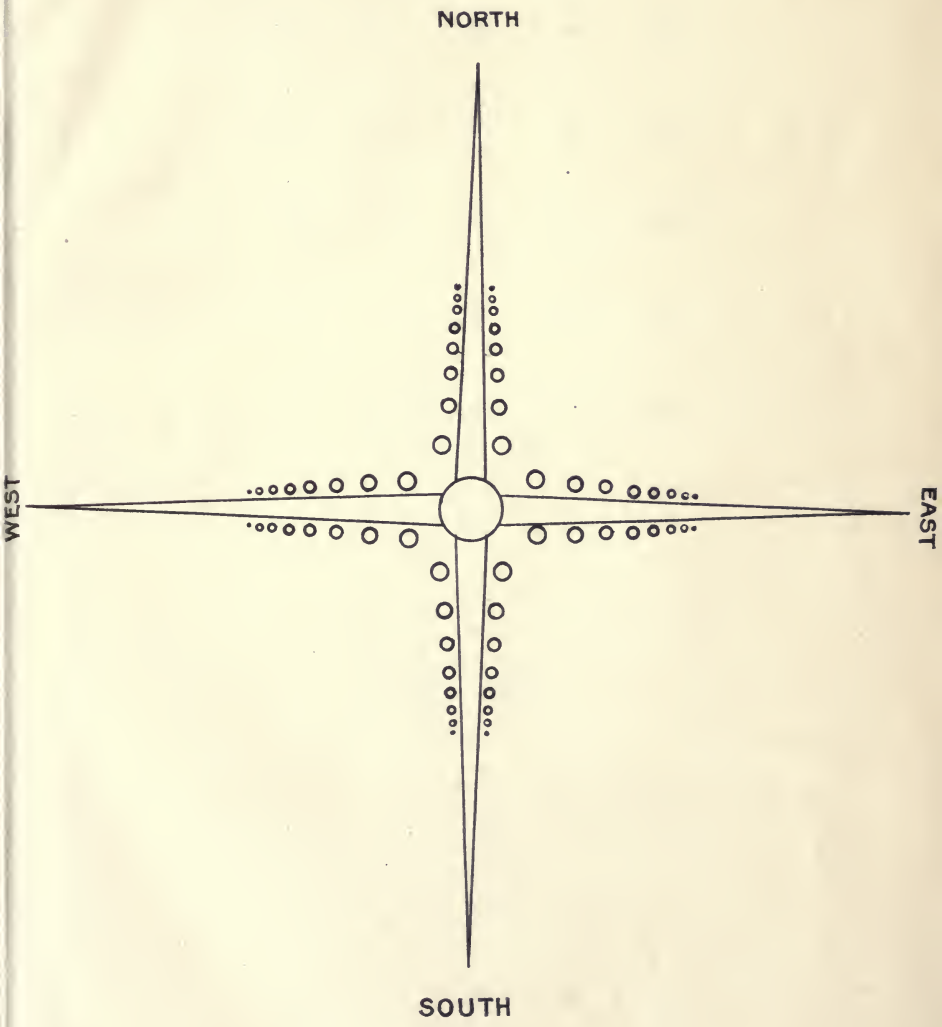

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Fig 5

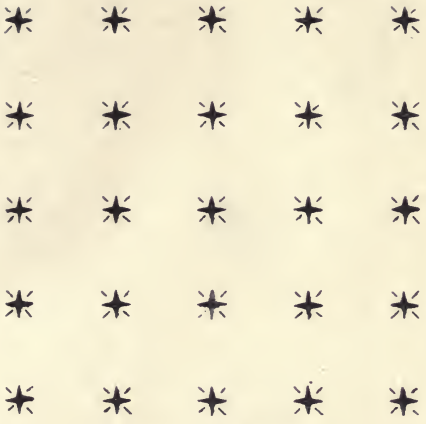

Fig. 6

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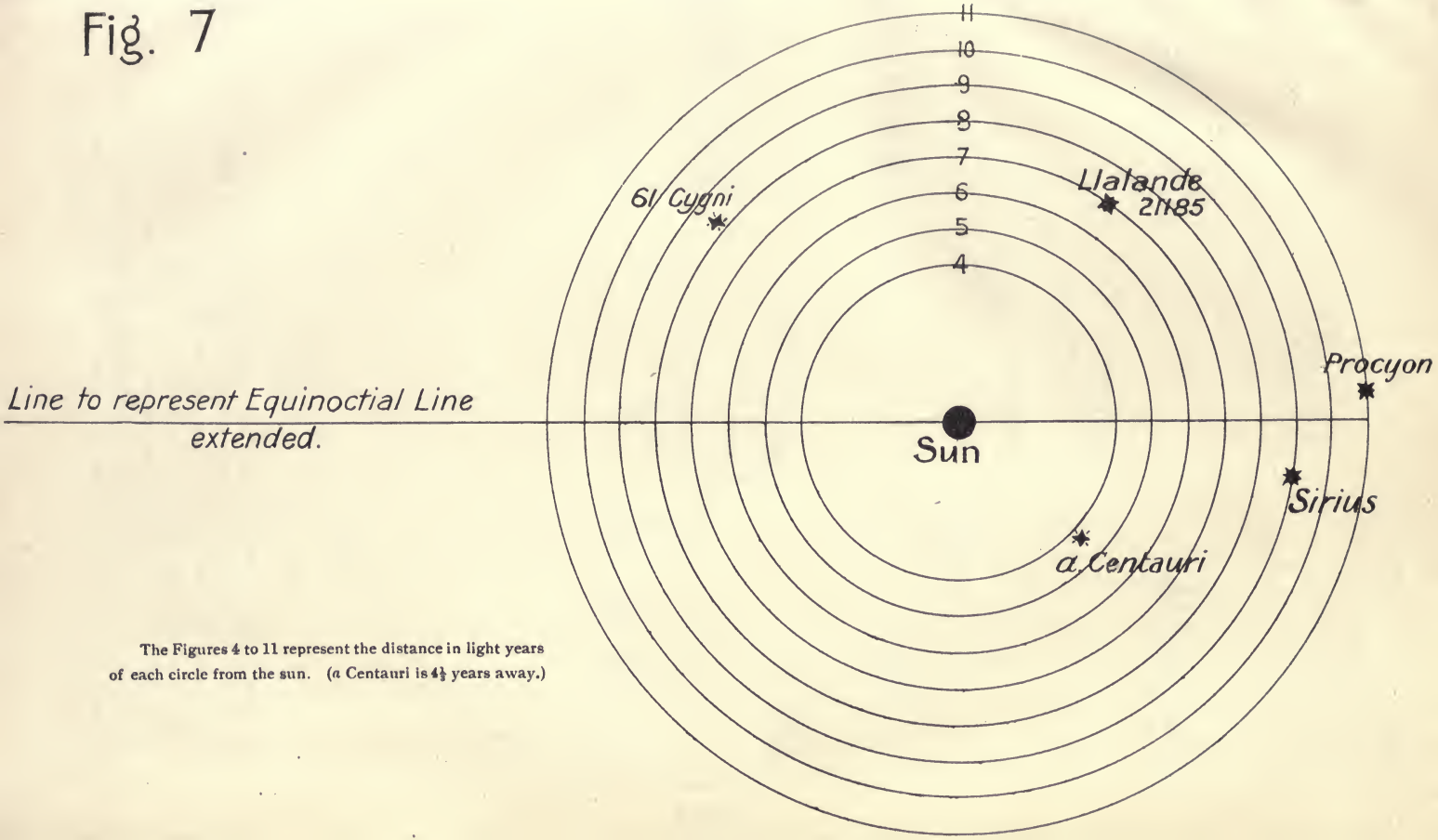
Fig. 7



The Figures 4 to 11 represent the distance in light years of each circle from the sun. (α Centauri is 4½ years away.)

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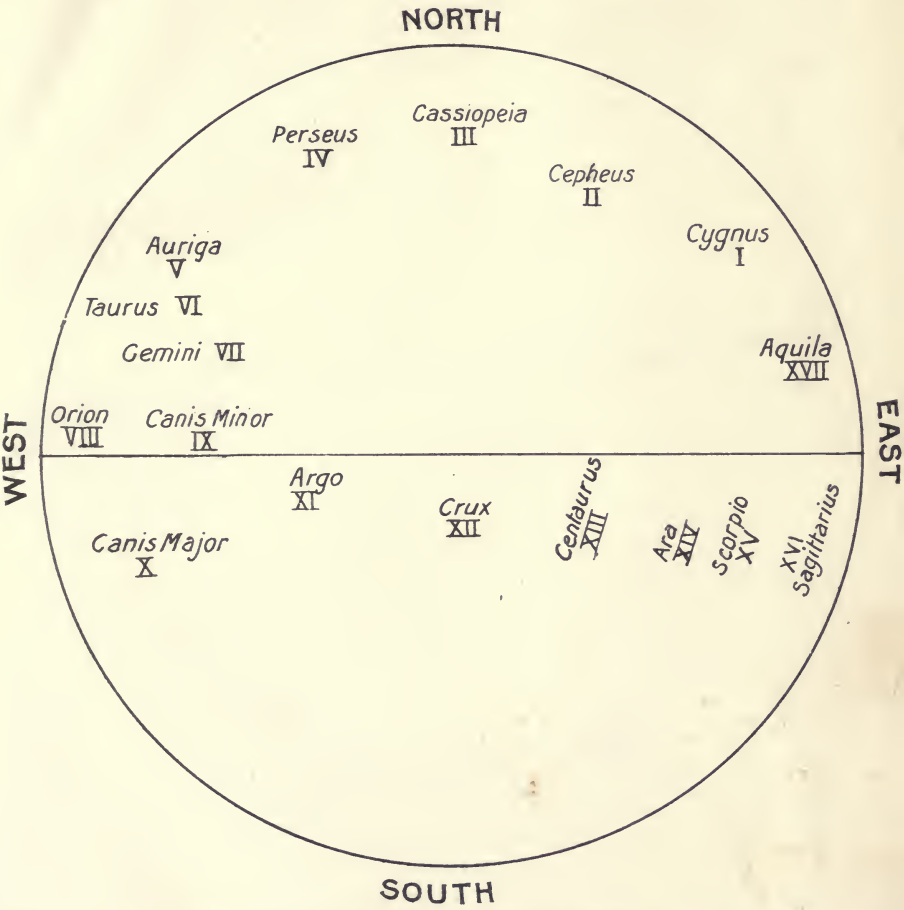
Fig. 8

March 21 *Midnight.*



In Figures 8-11, I have taken the liberty of putting the East on the right side. In astronomical maps it is usually put on the other side, and sometimes the South is put at the top. This topsy-turvy method engenders some mental confusion with beginners, and may possibly have the like injurious effect upon even experienced astronomers, as I am gratified to find that such old hands as mapmakers are unsettled by it. For instance, in Proctor's Star Primer, Map 2, for second half of January, February North-East is put on the *right* side, which is the wrong side, and North-West is put on the *left* side, which is not the right side.

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Fig. 9

Sep. 21 . *Midnight.*

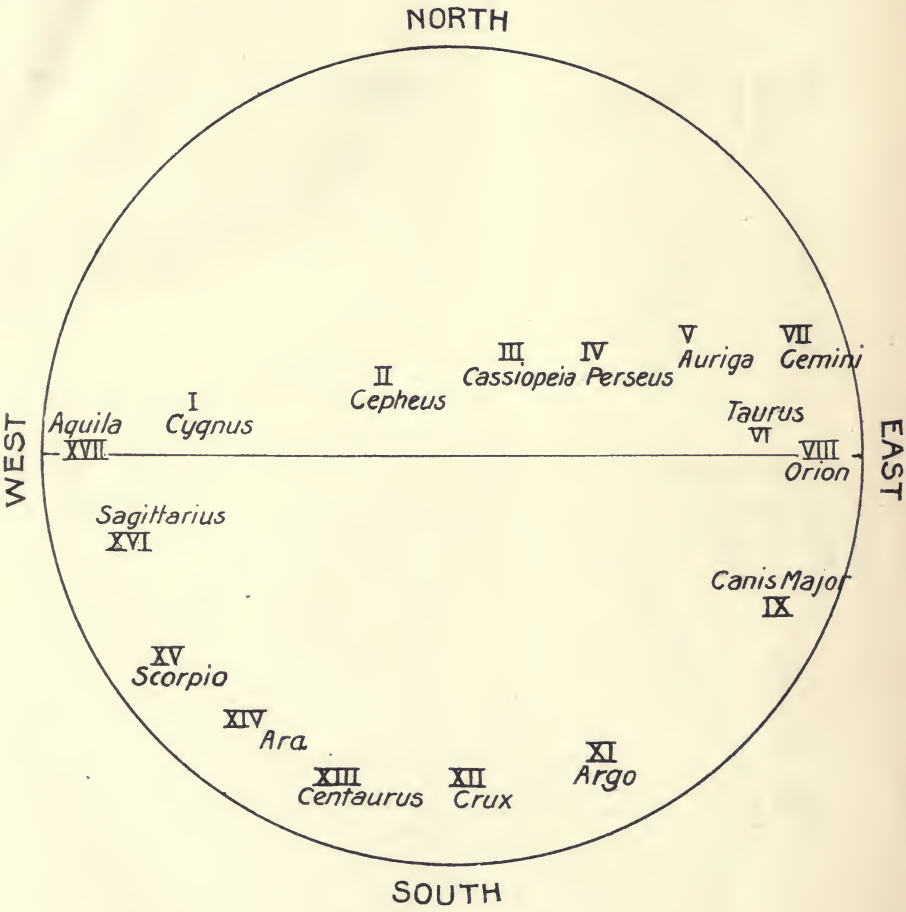

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Fig. 10

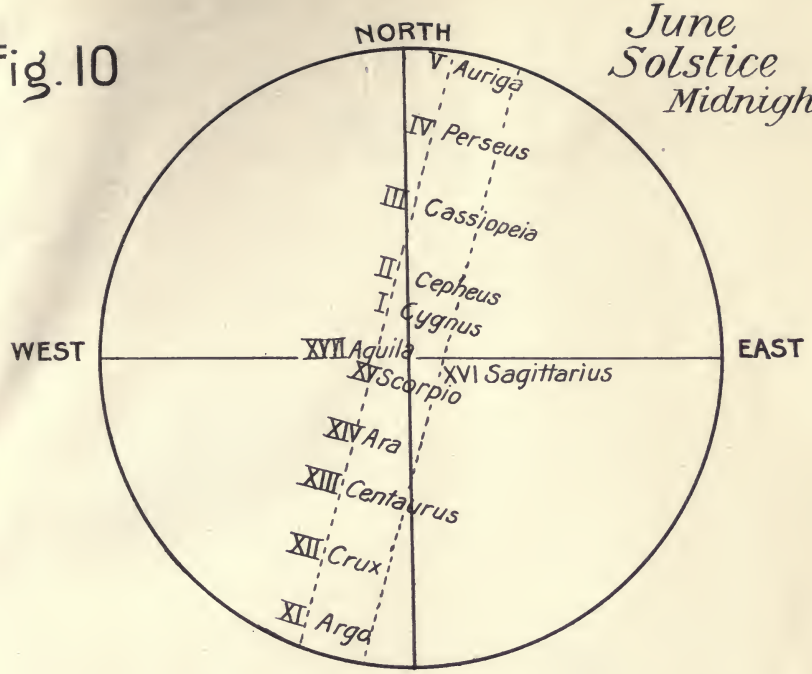
NORTH
June
Solstice
Midnight.
V Auriga
IV Perseus
III Cassiopeia
II Cepheus
I Cygnus
WEST
EAST
XVII Aquila
XV Scorpio
XVI Sagittarius
XIV Ara
XIII Centaurus
XII Crux
XI Argo

Fig 11

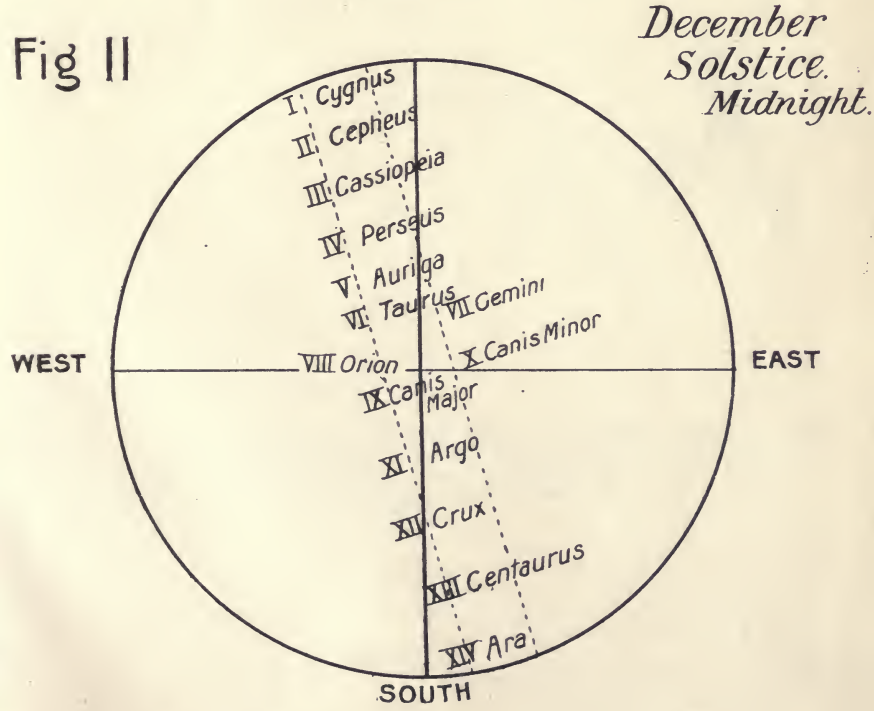
December
Solstice.
Midnight.
I Cygnus
II Cepheus
III Cassiopeia
IV Perseus
V Auriga
VI Taurus
VII Gemini
X Canis Minor
WEST
EAST
VIII Orion
IX Canis Major
XI Argo
XII Crux
XIII Centaurus
XIV Ara
SOUTH

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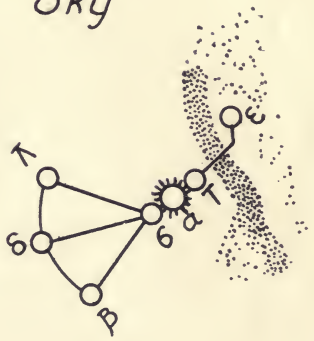
Fig. 12

Map

1

Sky

2



No. 1 is Scorpio's position relative to the Milky Way stream, as given in Peck's Map for 35°/₀ South (*vide* Maps 6, 7, 8, and 9). No. 2 is Scorpio's actual position, as noted from observations between January and May, 1905.

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